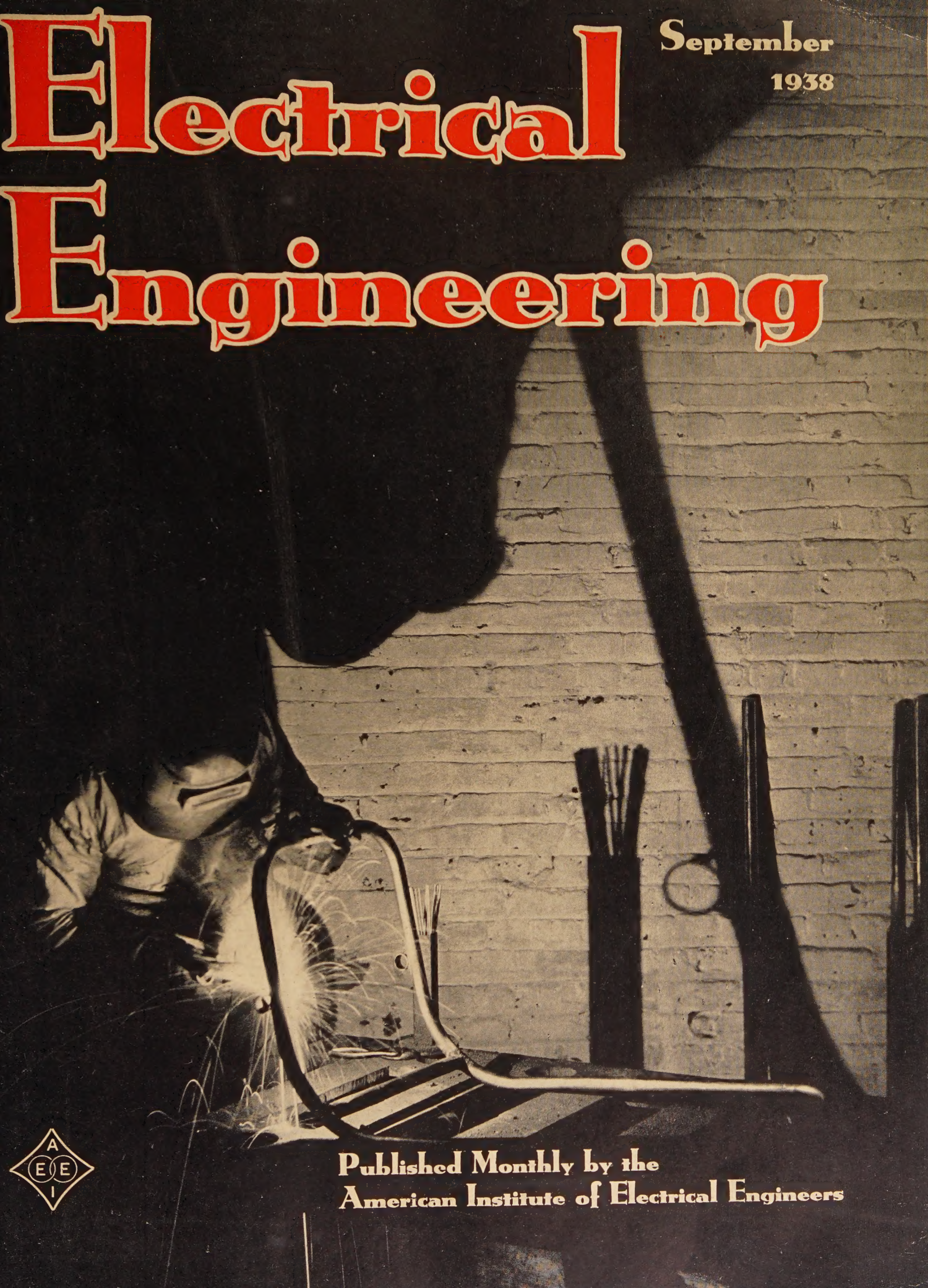
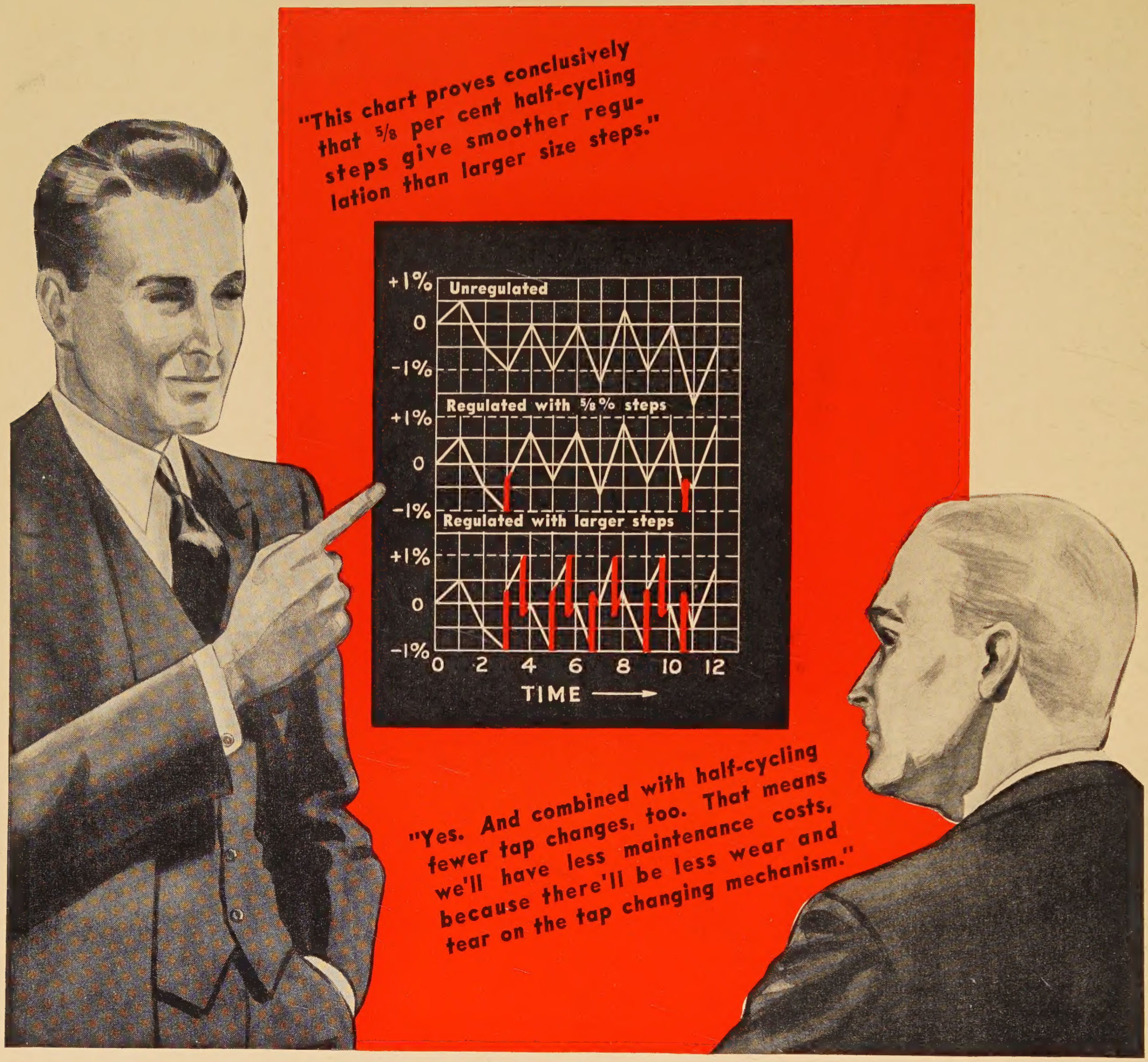
Electrical Engineering

September
1938



Published Monthly by the
American Institute of Electrical Engineers


"This chart proves conclusively that 5/8 per cent half-cycling steps give smoother regulation than larger size steps."
+1%
0
-1%
Unregulated
Regulated with 5/8% steps
Regulated with larger steps
0 2 4 6 8 10 12
TIME ⟶
"Yes. And combined with half-cycling fewer tap changes, too. That means we'll have less maintenance costs, because there'll be less wear and tear on the tap changing mechanism."

★ Increase Your Revenue With Allis-Chalmers 5/8 Per Cent Half-Cycling Step Regulators

You can't afford to have unregulated voltage on your lines, because that means loss of revenue and dissatisfied customers. And yet, if you invest in a step regulator, you want the utmost in regulation at the lowest possible cost. That is why the chart these men are studying has an important bearing on your profit and cost columns. Look at it closely. You can see at a glance that regulation with 5/8 per cent steps, plus half-cycling operation, makes voltage smoother and steadier — *and does it with only two tap changes and two switching operations.*

Compare that record with that shown by the curve for larger size steps and full cycling. Voltage not as smooth, and, what's more, nine tap changes and eighteen switching operations in the same length of time. What does this mean to you? Just this: With 5/8 per cent steps and half-cycling you get closer regulation with fewer tap changes, and that means less contact deterioration and less maintenance costs. Many step regulators have appeared on the market since Allis-Chalmers first introduced the step regulator. But remember—Allis-Chalmers is still the only company that builds your step regulator with 5/8 per cent steps and half-cycling operation as standard equipment. And that means that only with the AFR (for station installation) and the DFR (for distribution systems) can you obtain the maximum in regulation at the minimum in costs. Choose the AFR or DFR units and discover for yourself how quickly they pay for themselves by increasing your revenue.

871

TRANSFORMER DIVISION
ALLIS-CHALMERS
MILWAUKEE · WISCONSIN

Electrical Engineering

Registered U. S. Patent Office

for September 1938—

Engineering Orientation ...John C. Parker ...369
Electrification of the Bay-Bridge Railway ...Paul Lebenbaum ...372
Tensors—in "Words of One Syllable" ...H. H. Skilling ...378
Noise Specifications for Power Transformers ...382
Our Scientific Era ...Alfred Still ...384
Abstract: Transmission Theory of Spherical Waves, 383
News of Institute and Related Activities *(See next page)* ...387

Transactions Section—Papers and Correlated Discussions *(Follows EE Page 402)*

System Planning and Operation for Voltage Control ...T. J. Brosnan ...493
Regenerative Tension Control for Paper Winders ...H. W. Rogers ...495
Comparison of Methods of Stopping Squirrel-Cage Motors ...W. I. Bendz ...499
Capacitors for Power-Factor Correction in Industrial Plants ...C. E. H. von Sothen ...505
Multiple Lightning Strokes—II ...K. B. McEachron ...510
Photoelectric Weft-Straightener Control ...C. W. LaPierre and A. P. Mansfield...513
Protector-Tube Application and Performance on 132-Kv Lines ...Philip Sporn and I. W. Gross ...520
Corona Voltages of Typical Transformer Insulations Under Oil ...F. J. Vogel ...531
Systematic Voltage Surveys ...R. W. Burrell and W. E. Appleton ...535
Voltage Regulation in a Rural Distribution System ...G. H. Landis ...541
Voltage-Regulating-Equipment Characteristics ...P. E. Benner and G. S. Lunge ...548
A D-C Transformer ...T. C. Lennox and E. V. DeBlieux ...554

©

VOLUME 57 NUMBER 9

Published Monthly by the

American Institute of Electrical Engineers
(Founded 1884)

JOHN C. PARKER, President H. H. HENLINE, National Secretary

PUBLICATION COMMITTEE—I. Melville Stein, *chairman* J. W. Barker O. W. Eshbach H. H. Henline
A. G. Oehler H. S. Osborne H. S. Phelps H. H. Race D. M. Simmons M. W. Smith

—PUBLICATION STAFF—

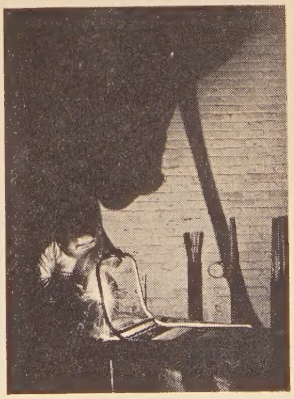
G. Ross Henninger, Editor
Floyd A. Lewis, Associate Editor
F. A. Norris, Business Manager
C. A. Graef, Advertising Manager

Entered as second class matter at the Post Office, Easton, Pa., April 20, 1932, under the Act of Congress March 3, 1879. Accepted for mailing at special postage rates provided for in Section 1103, Act of October 3, 1917, authorized on August 3, 1918. ¶ Publication Office: 20th & Northampton Streets, Easton, Pa. Editorial and Advertising Offices at the headquarters of the Institute, 33 West 39th Street, New York

The Cover

Welding an airplane-chair frame electrically

Lincoln Electric Company Photo



High Lights

Voltage Regulation. Design and operation of the various parts of a power system are influenced by the permissible limits of voltage regulation, which vary for different types of load. The recent addition of new devices having low power factor and high starting current increases the importance of co-operation between manufacturers, contractors, and power companies (*Transactions pages 493–5*). A planned voltage survey may be made with both graphic and indicating instruments to determine voltage conditions in the distribution system (*Transactions pages 535–40*). Rural distribution systems have special problems because of the low load density, long distances, and need for minimum cost (*Transactions pages 541–7*). Selection of the proper type of voltage-regulating equipment to correct a given undesirable condition requires consideration of economic as well as technical factors (*Transactions pages 548–53*).

D-C Transformer. The design of devices employing mechanical commutators for transforming direct voltages involves two difficult problems: the provision of correct current collection and commutation. By using two commutators on the same shaft and connecting them to the high- and low-voltage windings of a suitable transformer, some of the usual difficulties of design may be obviated (*Transactions pages 554–8*).

Discussions. Beginning with this issue, all discussions published in the TRANSACTIONS will be correlated with their respective papers, the last remaining discussions of previously published papers having been published in the August issue. This marks the completion of the transition from the publication policy in effect during the years 1934–37 to the new plan as announced on page 1409 of the November 1937 issue of ELECTRICAL ENGINEERING.

Corona Voltages. An earlier investigation indicated that for transformer insulations under oil, electrical breakdown adjacent to square edges is a function of the stress and the distance over which this stress acted; experimental data now have been obtained that support the theory and permit its application in the practical design of transformers (*Transactions pages 531–5*).

Control for Paper Winders. In winding paper on rolls, the tension of the sheet ordinarily is controlled by a manually operated mechanism, but constant tension is extremely difficult to maintain in this manner. Tension control may be improved electrically, by means of a regenerative system of motors and generators (*Transactions pages 495–9*).

Tensor Analysis. During the last few months some readers played games with tensors, engaging in hunts and other things not entirely decorous in conventional mathematics. The unusual approach to this perfectly serious realm of mathematics now seems to be the order of the day, for in this issue an author paints a word picture, figuratively, in words of one syllable (*pages 378–82*).

New Transactions Format. Beginning in this issue, the TRANSACTIONS section will be published in a three-column format instead of the former two-column format. The new arrangement not only provides improved readability but also effects some space economy. Comments and criticisms are solicited.

Lightning Protection. For maintenance of proper protection, devices designed to protect apparatus from the effects of lightning should not include mechanical motions that take time for restoration to normal condition (*Transactions pages 510–12*).

Braking Motors. Each of the several methods of quickly stopping squirrel-cage induction motors has its advantages and disadvantages. A comparison of four of the most commonly used methods aids in the choice of the one best suited to a particular application (*Transactions pages 499–505*).

Weft-Straightener Control. A new photoelectric weft-straightener control has improved the quality of the products of weaving mills by straightening the weft threads continuously and automatically (*Transactions pages 513–19*).

Protector-Tube Application. A paper in this issue presents statistical and interpretive information on the performance of protector tubes for protecting 132-kv transmission lines against lightning (*Transactions pages 520–30*).

News 387

Portland Sets New High for Coast Convention.... 387
AIEE Directors Meet at Institute Headquarters.... 389
Plans Progressing for Southern District Meeting.... 390
Three Committees on Applications Combined.... 390
Institute Funds for Research Projects.......... 390
Future Meetings
  AIEE.................................. 389
  Other Societies.......................... 391
Letters to the Editor......................... 392
  Journals for Electrical Engineers.............. 392
  The Role of the Engineering Library........... 392
  Ambient Temperatures for Transformers........ 392
Personal Items.............................. 394
Membership................................. 395
Engineering Literature........................ 396
Officers and Committees....................... 397
Pamphlet Copies of Papers Available........... 402
Industrial Notes..............(See advertising section)
New Products...............(See advertising section)
Employment Notes...........(See advertising section)

Electrification of Bay Bridge. The great San Francisco–Oakland Bay Bridge soon will add to the convenience of commuting across the bay for about 50,000 people, when its three electrified railway lines are placed in operation (*pages 372–7*).

Capacitors. Substantial savings in power costs may be effected by industrial customers by the use of capacitors to improve the power factor of the load (*Transactions pages 505–09*).

Our Scientific Era. A teacher of technical subjects looks at the historical aspects of scientific change and challenges the reader with some thought-provoking questions (*pages 384–6*).

Pacific Coast Convention. More than 450 members and guests registered at the recent AIEE Pacific Coast convention held in Portland, Ore. (*pages 387–9*).

Officers and Committees. Officers and committees chosen to serve the Institute during the year 1938–39 are listed in this issue (*pages 397–401*).

Coming Soon. Among special articles and technical papers now undergoing preparation for early publication are: an article on labor policy and employment, by Leo Wolman, noted economist; an article discussing the relationship that research, engineering, and education bear to social progress and welfare, by R. E. Doherty (M'27); an article emphasizing the importance of research in developing new products for industry, by Vannevar Bush (F'24); an appreciation of 1937 Lamme Medalist R. E. Doherty, by A. R. Stevenson (F'37); an article presenting test results on the influence of utensils on heat transfer from electric-range units, by W. G. Short (A'38); a paper discussing the application of a large phase-shifting transformer on an interconnected power system loop, by W. J. Lyman (A'25) and J. R. North (M'29); a paper presenting installment III of the results of a continued series of tests on oil-impregnated paper, by H. H. Race (M'31); a paper presenting the results of field testing of bushings and transformer insulation by the power-factor method, by I. W. Gross (A'12); two papers on the newly developed telephone instruments—one describing the instruments themselves, by W. C. Jones (M'29) and the other presenting the transmission characteristics of the new units, by A. H. Inglis (A'22); a paper discussing the wound core for distribution transformers, by E. D. Treanor (M'36); a paper describing a self-checking system of supervisory control, by M. E. Reagan (M'30); a paper describing a combined thyratron and tachometer speed control for small motors, by A. J. Williams, Jr. (A'27); and a paper on the protection of 22-kv substations against lightning, by E. R. Whitehead (A'30).

Statements and opinions given in articles and papers appearing in ELECTRICAL ENGINEERING are the expressions of contributors, for which the Institute assumes no responsibility. Correspondence is invited on all controversial matters. ¶ Subscriptions—$12 per year to United States, Mexico, Cuba, Porto Rico, Hawaii, Philippine Islands, Central and South America, Haiti, Spain, Spanish Colonies; $13 to Canada; $14 elsewhere. Single copy $1.50. ¶ Address changes must be received by the fifteenth of the month to be effective with the succeeding issue. Copies undelivered because of incorrect address cannot be replaced without charge. ¶ ELECTRICAL ENGINEERING is indexed annually by the Institute, weekly and monthly by *Engineering Index*, and monthly by *Industrial Arts Index*; abstracted monthly by *Science Abstracts* (London). ¶ Copyright 1938 by the American Institute of Electrical Engineers. Number of copies this issue—20,500.

Engineering Orientation

By JOHN C. PARKER PRESIDENT AIEE

Matters important to every member of the profession were discussed by President Parker in his recent Pacific-Coast-convention address, presented here in full

FOR as long as I can remember, members of the engineering profession have been concerned about the status of their calling in the social body. This concern has not been entirely selfish. It has not been that individual discontent with compensation and with opportunity which is fairly common to all people, whether engineers or not, and which, incidentally, almost never seems to be relieved in the mind of the individual no matter how astronomical the figures that represent his income, or how Napoleonic his power.

It is true that studies have been made continuously over a long period of years having to do with the economic status of the engineer, and it is right and reasonable that such studies should be made if they can effectively be used as a guide to well-considered and fruitful conduct.

I think it is fair to say that most of the questioning, or even of the dissatisfaction, with the status of the engineer has been unselfish, both as expressed by individuals and as these inquiries have been pursued by professional groups. There have been strong differences of opinion within the profession as to the relative status of different branches of engineering both in the matter of recognition and in the matter of pay, but there has been a minimum of factional self-seeking or of indifference to the problems of other engineers in their diverse fields of activity and under widely different schemes of employment.

Whatever incidental or ultimate objectives may have been involved in the approach of engineers to a study of the status of their profession, two considerations have dominated all the discussions and all the thinking about it. First has been the query as to whether the profession has proper opportunity to render to society all the service of which engineering is capable and which the nation needs; and, second, has been the question as to whether engineering is fully understood and recognized in its professional aspects. The answer to both of these questions obviously must be "no."

No profession can ever hope to attain the absolute limit of its usefulness to society, nor is the appraisal of others ever likely to be a precisely correct one, though at some times and with reference to some professions there doubtless has been, by a part of the population, an exaggerated appraisal which may be quite as harmful in its effects as underestimate.

If we take for granted that neither can usefulness be absolute nor recognition quite precise, we approach the more practical question as to what we can do about it, and again, of course, the answer is that we will never attain completely all that we would wish. Nonetheless, by such continued questioning and by such sound means as we can practically apply, we can—we must—exert ourselves toward bringing our profession into a position more nearly representing its proper place in the social and political structure.

As a corollary, it seems almost inevitable that the economic status of the profession will, by the application of a reasonable degree of common sense and initiative, almost take care of itself. As a matter of fact, in passing, it might be noted that however greatly the individual engineer may have fallen short of full economic reward in the upper end of the scale, the profession as a whole has done pretty well for itself as compared with the other recognizably professional callings.

Among the definite efforts to establish the usefulness and the recognition of engineering there has been quite conspicuously presented to engineers the country over the matter of registration and licensing.

It is true that the Institute has been less interested in the process of registration than have engineers in other branches of the profession. This is quite what might have been expected from the very nature of our special engagement in professional work.

Whereas engineers in some other branches may, by the very nature of their engagement, find themselves—either as independent practitioners or in public employment—closely related to direct service of the public, electrical engineers more customarily have found their field in corporate employment.

The consultant and the independent designer have felt a need to protect at once the public, the profession, and themselves from the possibility that a public, unable to gauge professional attainments, might employ the services of people who, however well-meaning, could by no real standards be regarded as engineers.

Engineers in public employment similarly have felt the need to protect their calling and to protect the general public against the delegation of public engineering functions to place-holders.

There had been nothing to prevent any person who wished to do so from calling himself an engineer, and, so doing, offering his services to the unwary. Indeed neither public officials nor the general public have any adequate understanding of the niceties of technique, to say nothing of the economic and social significance, of competently engineered works.

On the other hand, in our branch of the profession, engineers generally have found direct employment in manufacturing concerns, in communication companies, the railways, great electric light and power systems of the country and other similar corporate enterprises. A smaller but appreciable number have practiced their profession as consultants or in the employ of consultants. The clients of the electrical consulting firms have, in the main, been corporate enterprises which I have just mentioned, themselves often headed by engineers, and in any event well enough advised of the seriousness of their undertakings discriminatingly to engage competent and ethical consultants.

In the last analysis, the responsibility to the public for electrical-engineering enterprise has generally been carried by corporate organizations which either have felt their social responsibility or, if not sensitive to that, at least have recognized legal and financial liability.

I believe that this one feature of employment conditions has led our branch of the profession to be less actively interested in the processes of licensure than have conspicuously the civil engineers.

Discussion at the Institute's 1938 annual conference of officers, delegates, and members in Washington, D. C., gave almost, if not quite, unanimous expression to the belief that electrical engineers have too long delayed a recognition of the inevitability of the process of license. Perhaps we have been too self-centered to get the perspective of engineering responsibility as it affects the work of engineers in other branches. Whether we be so or not, and whether we like it or not, the process of registration and license is with us in most of the states of the Union and will extend into other states. It has not yet reached final form. What its ultimate form will be and whether there shall be a degree of uniformity among the states depends on the members of the profession themselves. Easily it may degenerate into a self-seeking mechanism actuated only by the desire for selfish gain and arbitrarily restrictive of admission to professional practice; or it may, by the exercise of broad vision and co-operative effort become an agency of public service directed, as public service is its principal objective, to the elevation of the profession.

There are certain practical aspects of our approach to a uniform license law which I would mention in passing. With too great facility the American people rush into the making of statutes. With bitter or ludicrous experiences behind us, we never seem to learn that legislation cannot progress faster than does acceptance by the vast body of decent citizens. If our license laws attempt unnecessarily to restrict the supply of competent engineers, or if too great obstacles are placed in the way of employment in junior positions of engineers not yet eligible to license, people will find their way of dispensing with engineering services or of circumventing the law.

If the junior engineer is made to feel, during his period of probation, that he has no status with the profession, he will find other and most unprofessional allegiances. I believe there is a big field of usefulness for members of our branch of the profession to offer positive and sympathetic help in avoiding such pitfalls as these.

Too much, however, must not be expected from the processes of registration and license. At best they will prove only a useful implement for marking a minimum level. The fuller recognition of the profession and the advancement of the individual engineer must rest on lay appraisals by the general public. We cannot hope to legislate or to impose a compulsion of a reluctant public to esteem our profession nor even to increase our rate of compensation.

Other professions and, if you please, the trades have had their fling at these processes. The law and medicine have not been able to prevent ambulance chasing and fee splitting. Whatever the emoluments at the top of those two ancient professions, the rewards at the bottom end are unspeakably low, and as Doctor R. W. Sorensen pointed out in his 1938 summer-convention paper,* the average net compensation of lawyers and medical men is not as good as that of the average unlicensed engineer.

In the matter of esteem, I doubt if the average citizen thinks particularly well of lawyers, nor has the medical profession, for all its exacting processes of license, received the popular appreciation of its services which it so richly deserves.

I think I need only point to the controversies raging in the American Medical Association and to the continuous stream of articles flowing into the daily press to indicate that the medical profession today, in spite of its rigorous requirements for admission to practice, is in a most disturbed condition.

To the extent that engineering, with the other professions, has established itself economically and in social influence, the causes of success will be found much deeper. They lie in adequacy of preparation, breadth of perspective and a general professional orientation to the social body. Where professions have failed, one or another of these elements will be found to have been neglected.

These are things that cannot be legislated. They are qualities that do not belong to a profession as a whole but rather are personal and individual to the practitioners of that profession. Obviously, our profession as a profession can be competent only as individual engineers are competent. Perspective and social awareness are inherent in the individuals that make up a profession.

As with the other professions, so in engineering, the education and the processes of apprenticeship have improved rapidly. However short of the ideal we may fall, I think we have little reason, speaking in comparative terms, to question the preparation of the young engineer for the practice of his profession. Toward the attainment of a higher level, the Engineers Council for Professional Development is doing yeoman service and merits all the support that the members of the Institute can give it. Those of us who are somewhat older than the youngsters coming into the profession will do well to bear in mind that as the work of ECPD makes possible a higher level of education for engineering and more constructively developmental internships for the young engineers, our profession as a whole and we, incidentally, will benefit in public acceptance.

As to professional approach, I think engineers have little of which to be ashamed. On the contrary, I would almost hazard the claim that we have a more nearly professional attitude than the members of other professions. The intellectual integrity of the engineer is well recognized even to the extent, at times, of inducing the charge of unsympathetic inflexibility. Rarely does he become a special pleader, nor does he substitute an unctuous bedside manner for treatment of the patient.

---

* "The Economic Status of the Engineer," ELECTRICAL ENGINEERING, July, 1938, pages 281–5.

Engineers habitually approach their work with a sobriety and seriousness of purpose equalling that of the best practitioners of other professions. There is a detachment and a habit of factual analysis which, it seems to me, is of the very essence of the professional method.

These things the profession has done well and is on its way seriously and steadfastly toward greater performance. They are essential to the well-being of the profession and to its ability to discharge its obligations to society. To these must be added keen awareness of the rightful function of engineering in the social organism. This is the thing which, for want of a better name, one might call perspective. A broader perspective both within the profession and in an extramural sense will bring about fuller professional recognition and larger rewards. It is not enough that an electrical engineer be able never so skillfully to calculate the electric and magnetic circuits of a motor or the characteristics of a transmission line. He must, in the former case, be able through mechanical linkages to relate his motor to the operating characteristics of the driven appliance, and in the latter case must realize that his transmission circuits need structural supports, to the design of which there is essential as nice work by the civil engineer as by the circuit expert.

After we have, in sympathetic collaboration with the chemical engineer, developed magnetic materials better adapted to our communication circuits, and better processes of combustion in our boiler houses and of utilization in our furnaces, we find ourselves relating our engineering design to the processes of shop production and field construction. Our best engineering cannot be done by specialists except as these have a sympathetic and respectful appreciation of the work of other and equally important specialists.

Beyond this, of course, engineering is essentially an economic process. Be our work never so perfect technically, it is of little value to the world if it is not subjected to sound and competent balance of operating and carrying costs against benefits created.

Our duty, however, goes much further than this. As the surgeon falls short of his social duty if he regards his work as a series of "beautiful cases" while each patient regards his particular personal operation as a means to human health and happiness, so we will miss our entire objective if our job is merely technically and economically sound. We cannot ask the general public vastly to concern itself with the technical beauty of our work. Human beings are too self-centered for that sort of thing. Men will appraise our work and us as our performance expresses our keen interest in them and our desire to make ourselves of service to them.

It is a great achievement to have been able, through the ether, to transmit sound through space. It is monumental to have been able to broadcast from London or Paris to the remote farm in the New England hills or the Deep South, but it is vastly more important than that we should hear voices to be sure of what we hear.

As engineers, we take a justifiable pride in our tunnels under broad rivers, our networks of highways flung over the country, and our bridges spanning space. We must concern ourselves equally with the use to which men put these facilities. Are they the means not only for a richer commerce but for easy access of man to man in an increasingly civilized society, or shall they become only the primrose paths that lead to the everlasting bonfires? Shall our agencies of communication be the instruments of more civilized thinking or shall they be the tools of propagandists? Shall a degenerating jazz or ennobling music fill our ears and our souls? Shall our automobile roads be military highways for aggression and destruction, and the convenient means of escaping from sordid homes to blatant roadhouses, or shall they build suburban homes by providing an escape from urban congestion?

These things, as engineers, we must ponder. You say, and rightly, that we as a professional society cannot do much to determine the use that shall be made of our creations. That must be granted, but I do suggest that a proper perspective, an extension of professional thought to the social significance of what we do, will enable us as individuals to bring into the service of mankind for a higher good those qualities of honest, objective, and keenly analytic imagination which our profession possesses in a peculiar degree. We cannot do less than this. If, as individuals, to the other obligations which our high calling has laid on us, we add that of thinking and feeling in terms of the social significance of our works, we will find people not so surprised at the occasional discovery that an engineer is, after all, a human being.

If, not as engineers but as citizens, we interest ourselves more in the cultural and philanthropic activities of our communities; if doing so laymen of discriminating judgment have opportunity to discover qualities of the engineer, I am sure that the social emphasis placed on our engineering works will be changed for the fuller happiness of mankind. Perhaps too we shall learn that it is just as easy to make an engineering undertaking beautiful as it is to make it an offense to the sensibilities of nonengineers.

As we bring about, through a more active interest in the affairs of other men, a fuller realization of what engineering qualities can offer in nonengineering fields, the direction of engineering undertakings and the legislative influences surrounding them will more fully come into the hands of our profession.

The world today is in turmoil. Intolerance, impatience, and self-seeking, or even the well-meant efforts of starry-eyed idealists, easily may turn back the processes of painful human evolution.

Our profession has much to offer. That wealth cannot be placed at the disposal of mankind by a high-pressure campaign of publicity, but it can modestly and quietly be made an instrument of human betterment if individual engineers, without deserting those things which make them good engineers, will go out among the ways of men, giving to others the opportunity to discover that the great achievements which engineers have brought about in this industrial civilization of ours are not merely technical tricks and devices, nor alone the products of scientific research, but rather the result of a habit of mind and character which well can be put to use in fields far remote from technique.

Electrification of the Bay-Bridge Railway

By PAUL LEBENBAUM
MEMBER AIEE

Electrifying the railways on the great bridge across San Francisco Bay presented some unusual problems, and the completed system has many interesting features

ONE OF THE largest bridge projects ever undertaken, the $78,000,000 San Francisco–Oakland Bay Bridge now is open to vehicular traffic, and soon will be used for transporting 50,000 people to and from work every day on electric railways. At present these commuters, who live in Alameda County, across the bay from San Francisco, purchase 35,000,000 trips across San Francisco Bay each year on ferries operated by two Alameda County suburban-railway lines.

The bridge is a double-deck structure with roadways 58 feet wide, having a total length, including approaches, of $8^1/_4$ miles. The upper roadway is reserved for fast-moving vehicular traffic, the lower deck carrying a three-lane roadway for heavy trucks and an electric railway line in each direction.

As early as 1856 a bridge between San Francisco and Oakland was contemplated, but no serious intent was expressed until 1921, when private promoters petitioned the City of San Francisco for a franchise to construct such a bridge. No franchise was granted, however, and the project was deferred until President Hoover and Governor Young in 1929 appointed a special commission to investigate the economic necessity and engineering feasibility of the bridge.

In August 1930, the Hoover-Young Commission, after a thorough study, recommended the construction of the bridge, following which further developments were made in the designs and foundation surveys. In August 1932, a final report on the design and cost, as well as on traffic and income, was completed, and subsequently submitted to the Reconstruction Finance Corporation, with a request for complete financing through that body.

After a complete investigation, the project was declared by the RFC to have complied with all the requirements of a self-liquidating project, and it agreed to buy $61,400,000 worth of California Toll Bridge Authority bonds to finance the bridge, exclusive of interurban electric train service.

The financing of the interurban service was subsequently legalized by congressional act of 1934, following which the RFC earmarked about $16,000,000 of its funds for extending the rail systems of the Key System and the Interurban Electric Railway Company (Southern Pacific Company's subsidiary) from the east side of the bay into San Francisco.

The cost of the bridge railway includes the construction of a terminal building in San Francisco, its connection with the bridge proper by means of a loop, a storage yard on the present Key Mole, and the requisite rail connections with existing lines of the Key and Interurban. This part of the work will cost about $11,000,000. The other $5,000,000 will be expended for track changes in existing lines, so as to connect up with the bridge railway; for new car equipment, and for changing existing equipment to meet the requirements of operation over the bridge.

The principal and interest of the bonds issued for the railway facilities are to be met by passenger tolls, set at 2.5 cents per passenger for the first 18 months' operation, and the railways will absorb this amount during that period. Afterward, the volume of traffic handled will control the raising or lowering of the toll.

Power Requirements

How many kilowatts will it take to carry the commuters into and out of San Francisco during the morning and evening peaks; where will substations be located; what schedules and headways will be maintained; what length and weight of trains will be handled?

The Hoover-Young survey and other surveys and reports indicated that the Bridge Railway would have to be designed to carry 50,000,000 passengers annually, although the present traffic is about 35,000,000. It was on the basis of the higher figure that the operating officers of the two companies prepared the train consists (make-up of trains) and schedules. Schedules, of course, depend on speed; and speed, in turn, depends upon the ascending and descending grades. It happens that both Key and Interurban cars are geared so that their accelerating and running characteristics are approximately the same.

Maximum trains for the Key System will consist of seven new articulated units similar to those now being placed in service. Such a train is about 773 feet long, seats 868 passengers, and weighs, fully loaded, 541 tons. Each unit is equipped with four 110-horsepower motors, or a total capacity of 3,080 horsepower (5.7 horsepower per ton).

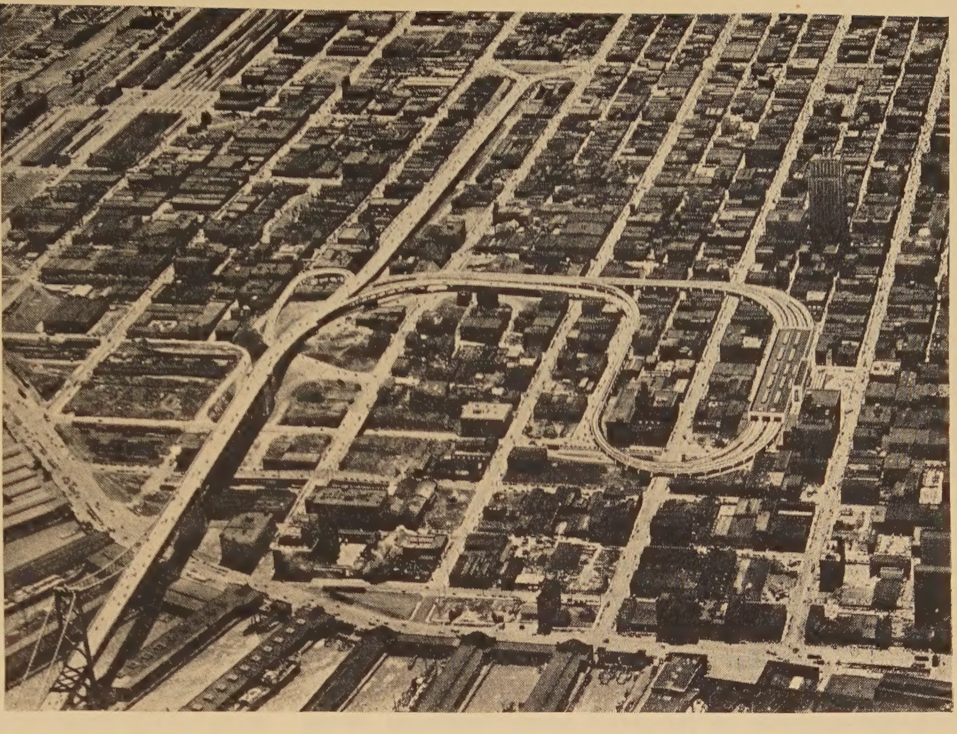
Similarly for the Interurban, the maximum train will consist of six motors and four trailers, weighing, fully

---

Based upon an address presented before the AIEE San Francisco Section, March 25, 1938.

Paul Lebenbaum is electrical engineer for the Southern Pacific Company, San Francisco. An electrical-engineering graduate of the University of California in the class of 1901, Mr. Lebenbaum started in engineering work as a tester for the General Electric Company, Schenectady, N. Y., then worked briefly on an electrification of the Northwestern Pacific Railroad before becoming associated with the Southern Pacific Company in 1903 as assistant electrical engineer. From 1909 to 1920 he was electrical engineer of the Portland (Ore.) division of the Southern Pacific Company. He returned to San Francisco in 1921 as assistant electrical engineer, and was appointed electrical engineer in 1932.

loaded with 1,160 passengers, 571 tons. Each power car is equipped with four 140-horsepower motors, or a total per train of 3,360 horsepower (5.9 horsepower per ton). The total length is 724 feet.



Aerial photograph showing the San Francisco terminal and loop of the Bay-Bridge railway

The Sacramento-Northern will operate one two-car train, weighing about 110 tons, in each of the two 20-minute periods during the evening peak.

The bridge engineers set 40 miles per hour as the limiting speed for trains; this to limit the impact load on the structure to a safe value. This is about the top speed of both Key and Interurban cars on the level. But there is not a foot of level track on the bridge. The 700-foot passenger-loading platforms at the San Francisco terminal are built on a 0.5 per cent grade, ascending in the direction of eastbound traffic. Leaving the terminal, the grade rises through a 20-degree curve, to a four-per-cent grade as far as Folsom Street; then a three-per-cent grade to a little beyond Tower *W*-4 at the pierhead line; then a long vertical curve, having its apex at the center anchorage, and again entering a three-per-cent descending grade just west of Tower *W*-7, the last on the West Bay crossing. From the Yerba Buena anchorage the grade rises to the center of the cantilever span over the East Channel in a series of grades varying from one per cent to 2.5 per cent. Then, after a short piece of 1.3 per cent, there is a 2.74-per-cent descending grade, practically a mile long.

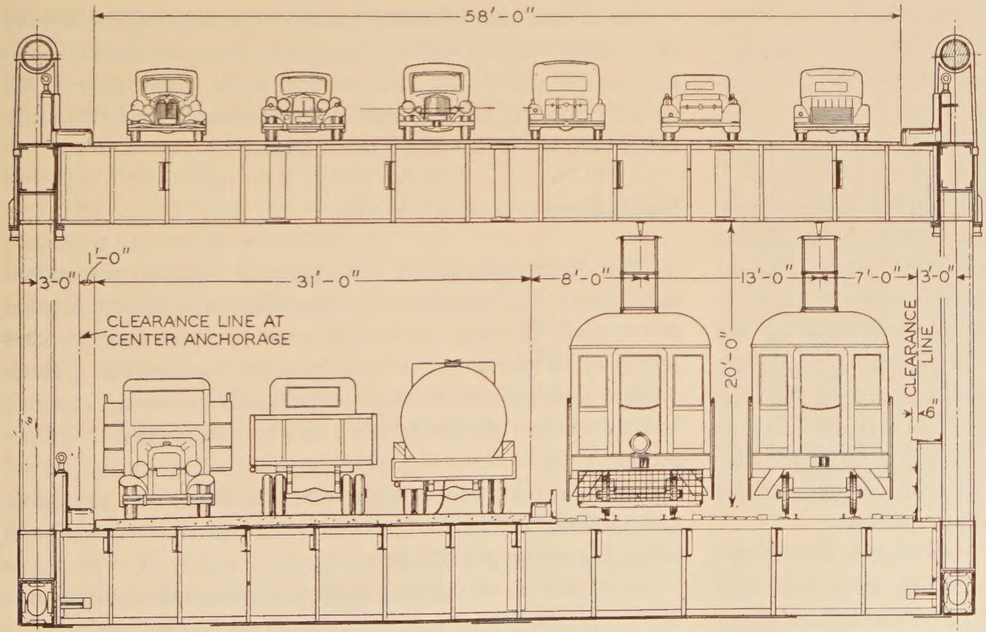
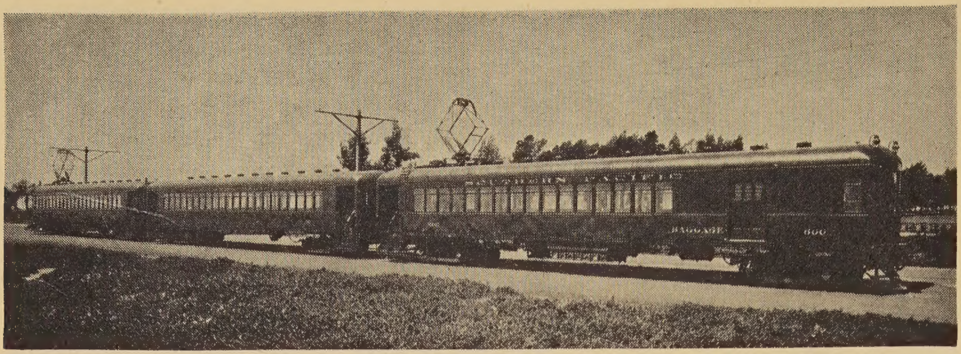


Diagram of a typical cross section through the Bay Bridge

As pointed out previously, the limiting speed on the bridge was placed at 40 miles per hour; therefore, the first thing the operating men wanted to know is the distance in which a full-length train running at that speed can be brought to a stop with an emergency brake application on both a three per cent grade and a 2.74 per cent grade. This *distance* determines the minimum headway between trains. Transposed into seconds, it was quickly found that this distance, for a train running at 40 miles per hour, was so great that not enough trains could be run during the peak periods.

Following a study of braking-time curves from speeds below 40 miles per hour, the maximum speed on descending grades for maximum carrying capacity of the tracks was set at 35 miles per hour. This will permit a headway of 63.5 seconds; however, it is expected that a 75-second headway will be sufficient to handle the volume of business offered at the opening of the



A train typical of those to be run across the San Francisco–Oakland Bay Bridge

Bridge Railway. This 75-second headway will permit operation of 15 trains, handling approximately 9,000 passengers in the 20-minute cycle beginning at 5:00 p.m., and an approximately similar operation in the following 20-minute period. This establishes the over-all period during which the maximum half-hour power demand is likely to occur, and to which the capacity of the substation conversion machinery must conform.

A vast majority of the riders travel westward in the morning and eastward in the evening, with comparatively light travel during all other hours. This results in a low load factor because of which the consumer—in this case the railroad—is penalized by paying a high rate for the power used. Conversely, it is just during this period that the railways obtain the minimum, or commuter, fare for the service they render.

The selection of sites for substations was limited by physical conditions to San Francisco, Yerba Buena Island, and the Key Mole. The Key operates at 625 volts. It had two choices: the first to place substations at San Francisco and the Mole; and the second, to place a third substation on the Island. The use of two substations would have entailed the installation of an excessive amount of feeder copper to keep voltage drops within reasonable limits; therefore, three substations are to be built. The Interurban, operating at 1,300 volts, will have substations at San Francisco and the Mole.

Power Supply

The selection of mercury-arc rectifiers for conversion from alternating current to direct current was almost inevitable. Their ability to carry momentary current overloads of from 500 to 600 per cent and their high efficiency at the lower loads are characteristics that cannot be duplicated by rotating apparatus. This is especially true for transportation service of the character under consideration; that is, for morning and evening peak loads that are very high as compared with the average all-day load, and for high momentary swings when starting trains on the grades and curves of the bridge railway.

As finally agreed upon, the Key is to install two 2,000-kw 625-volt rectifiers in each of the San Francisco and Island substations, and two 1,000-kw units at the Mole, where it already has a 1,500-kw automatic motor generator set which is to be remodeled to operate in parallel with the rectifiers. The Interurban will install two 2,500-kw 1,300-volt rectifiers in each of the San Francisco and Mole substations. Thus each company will have 10,000 kw in rectifier capacity. The Sacramento Northern will take its energy from the 1,300-volt system of the Interurban.

The half-hour d-c peak demands based on future maximum traffic, are as follows: for the Interurban at San Francisco, 4,250 kw; and at the Mole 3,100 kw. These demands overlap, so that the demand on which payments for power are made probably will be from about 6,500 to 7,000 kw. The load factor is less than 20 per cent; therefore, the Interurban under existing rate schedules, will pay for power in kilowatts, as distinguished from energy in kilowatt-hours.

For the Key, the half-hour d-c demands are expected to be 3,300, 3,080, and 2,970 kw for the San Francisco, Island, and Mole substations, respectively.

Three-phase 60-cycle power will be supplied to the substations by the Pacific Gas and Electric Company at 12,000 volts. San Francisco substation will be fed by three cables, each consisting of three 500,000-circular-mil conductors. One of these cables originates at its station *A;* the other two in Oakland, terminating in San Francisco at the power company's station *W*. These two cables are so connected to the 12-kv bus in the railway substation that it can be fed from either side of the bay.

The Mole substation will be served at 12 kv by three feeders, each consisting of three 750,000-circular-mil conductors. These cables originate in the new switching station adjacent to the power company's station *C* in Oakland.

The Island substation of the Key System will be fed by two cables, which will be energized from an outdoor extension of the 12-kv bus in the Mole substation. All substations will be automatically operated, and remotely controlled from the Mole substation.

Switchgear

The 12-kv switchgear structure in the San Francisco substation, and also those in the Mole and Island substations, is of the metal-clad single-bus type, divided into two sections, which are connected by a bus tie breaker. Each section is connected to one incoming feeder, and the third feeder (except at the Island) can be connected to either section.

The following refers only to the San Francisco and Mole substations, although the Island substation is designed along the same general lines.

Each section of the bus feeds one 625-volt rectifier, one 1,300-volt rectifier, and one house transformer bank. The oil circuit breakers are 600-ampere three-pole single-throw, with an interrupting capacity of 500,000 kva at rated voltage, mounted in a completely enclosed steel bus structure. They are d-c solenoid-operated at 125 volts, are trip-free, and of the lift-up type. The stationary upper circuit-breaker terminals are mounted in the switchgear housing; a built-in elevating device permits raising and lowering the breaker between the operating and disconnecting positions. When in the lower position, the breaker may be rolled out of its compartment, by means of a transfer truck, for inspection and test purposes. Suitable extension cables and connectors are provided for control purposes so that the breakers can be operated both mechanically and electrically while disconnected from the bus.

Current transformers are built directly into the switchgear structure. Potential transformers are placed above the circuit breakers, in a steel enclosure having a hinged door, the opening of which disconnects the transformers from the bus. Each switch compartment is equipped with potheads having stuffing-box connections. Switchboard-type hinged panels are mounted on the switchgear, on the side opposite to that on which the circuit breakers are located. Mounted on these panels are the necessary ammeters, relays, watt-hour meters, control switches, lamps, test blocks, and a miniature bus.

Mercury-Arc Rectifier Equipment

All rectifiers, except the 1,000-kw 625-volt units, have 12 anodes which are fed from the low-voltage windings of the main transformers, the high-voltage windings of which are delta-connected. The Key transformers have four $2^1/_2$-per-cent full capacity standard taps below 12 kv to provide for setting the transformer at the voltage that will normally be delivered to the substation. The d-c output will be 625 volts. The Interurban transformers will have a two-per-cent tap above 12 kv, and five two-per-cent taps below. This will permit Interurban to adjust its rectified voltage through the range from 1,275 to 1,350, the object being to use that voltage which will permit its cars to operate at approximately the same speeds as the Key's.

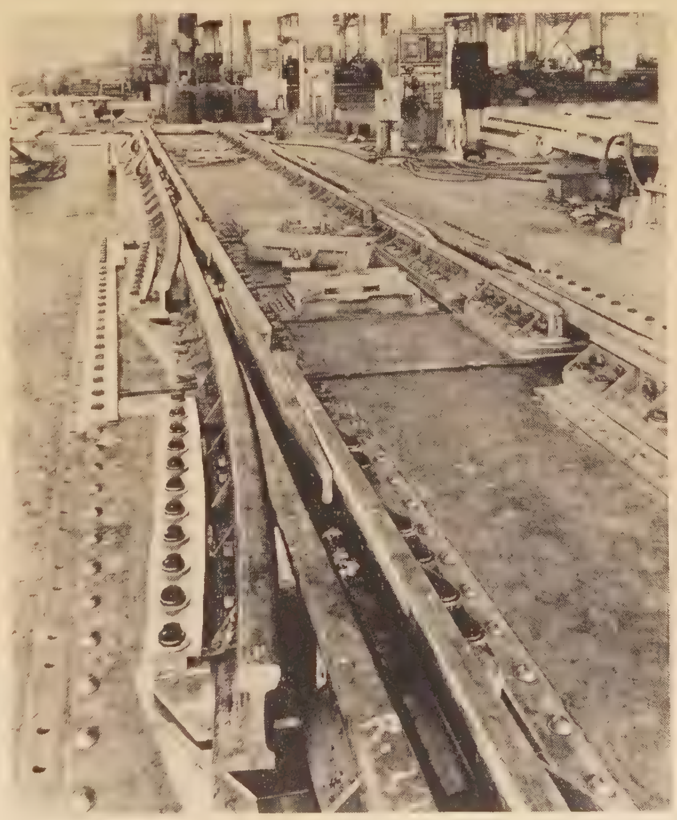
Tap-changing equipment is designed for operation under no load. For the Key it is manually operated. For the Interurban it is motor-operated by remote control, the position of the switch being given by a Selsyn indicator at the Mole substation.

The low-voltage windings are made up of four zigzag-connected wyes, providing a 12-phase supply to the anodes. The neutrals of these wyes are brought out for connection to the interphase transformer. The interphase transformer consists of three separate transformers mounted in a single tank. Two of the windings serve to connect the center points of the main transformer wyes to provide two six-phase connections. The center points of these two windings are, in turn, connected together through the third winding. A center connection to this winding provides the negative connection for the system.

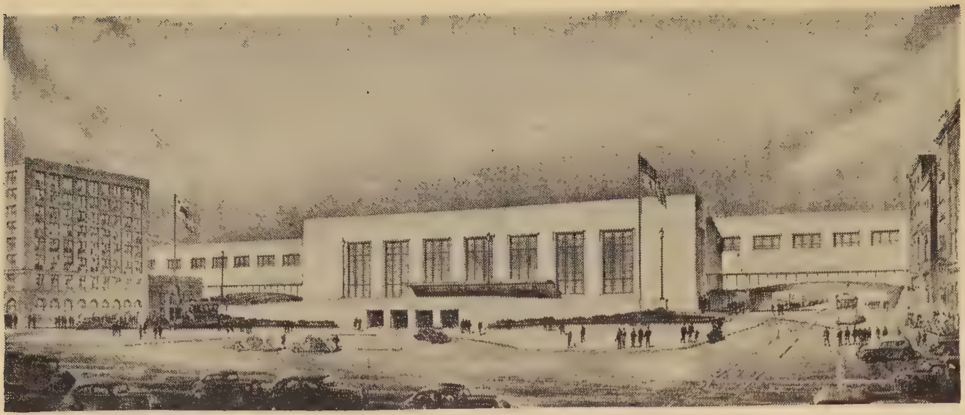
The voltage characteristic of the unregulated rectifier is of the shunt type, with approximately five per cent regulation from no load to full load. The necessity for attaining maximum train speed out of San Francisco over the peak periods, made it imperative to hold constant voltage at the d-c bus up to 150 per cent of the rectifier rating. This is accomplished by the addition of grids to the anodes; they reduce the output voltage at low loads below the natural characteristic to provide constant voltage output.

The rectifier tank is cooled by a system in which the treated cooling water is continuously recirculated through the rectifier. The amount of water is regulated by a thermostatically controlled valve, and is cooled by means of a fan-cooled radiator, the motor on which is operated only when required by means of a thermal relay. The mercury-condensation pump is cooled by a similar, but smaller, cooling system.

Rectifiers are put on and taken off the line by supervisory control. When the supervisory relay gives the indication, and when the three-phase voltage of the proper value is available, the automatic control equipment is allowed to function. When the tank temperature is within predetermined limits and when the pressure in the tank is sufficiently low, the master control contactor closes, the exciting arc is established and is maintained until the rectifier is shut down. The oil circuit breaker is then closed, applying voltage to the main anodes, after which the d-c circuit breaker connects the rectifier to the d-c bus.



Photograph showing method of compensating for thermal expansion in both running and guard rails. The link and coupling arrangement between the two running rails is for equalizing the total bridge movement between the sliding joints



Most recent architect's drawing of the San Francisco–Oakland Bay Bridge railway terminal being erected in San Francisco

Each unit is also provided with automatic devices designed to protect at all times against the following abnormal conditions:

1. Low or single-phase a-c supply voltage.
2. Severe a-c overcurrent.
3. Arcback.
4. Succession of arcbacks, in which case rectifier is shut down and locked out.
5. Transformer overtemperature.
6. Too high or too low rectifier tank temperature.
7. Too high rectifier tank pressure.
8. Failure of cooling water to the mercury condensation pump.
9. Too high blower, vacuum or water pump motor temperature.
10. Failure of rectifier to be connected to a-c or d-c system within a predetermined time, in which case rectifier is shut down and locked out.

Studies made by the engineers of the manufacturers, indicated that no interference with communication circuits would result from the harmonics in the rectifier output voltage and current. The principal reason for the absence of interference is that all of the communication conductors in the area that might be affected are located in underground duct lines. These studies also indicated that there was little likelihood of interference on the supply side, as both the power and telephone cables are in underground ducts.

D-C Switchgear

All circuit breakers for 1,300-volt service are high-speed, bucking-bar type, mounted in removable trucks, which, when in place, form a portion of a completely metal enclosed bus structure. Each truck carries with it a steel instrument panel on which are mounted the ammeter and protective and functional relays where required. A truck cannot be removed with the breaker in the operative position. A set of finger contacts mounted on porcelain supports on the removable truck engage with a set of blade contacts similarly mounted in the stationary structure. These latter are connected to the 4,500-ampere main bus. When they are pulled out, the circuit breaker may be operated while being tested and inspected.

In each station the 1,300-volt rectifiers are connected to the bus by 3,000-ampere solenoid-operated breakers, equipped with holding coils and magnetic blowouts. They operate automatically when the rectifier is started or stopped, and clear the machine in event of reverse flow of current.

The feeder breakers are also solenoid-operated, but in addition, are equipped with devices that open the breakers on short-circuit-current values which are less than the overload settings of the breaker. They are equipped with the necessary resistors, contacts, and relays for automatic reclosing with the use of feel-out resistors, provided that load conditions on the feeder are within set limits.

Supervisory Control

The supervisory-control apparatus to be used for remote control of the San Francisco and Island substations is known as the Visicode type, using standard telephone relays, and requires two line wires between the dispatching office in the Mole station and the Island, and two between the Mole and San Francisco. Telemetering facilities will be provided so that the dispatcher in the Mole substation may have a knowledge of conditions at the other substations.

At the Mole the rectifiers will be started and stopped by push buttons, and by the supervisory control at the other two substations. The operator at the Mole will start and stop the machines by closing or opening the 12-kv a-c circuit breakers, whereupon the machines will connect themselves automatically to the a-c and d-c buses. Both supervisory control and telemetering are carried on over the same pair of wires to each substation.

For the San Francisco substation there will be a total of 35 supervisory operations. Similarly, for the 625-volt Island substation, a total of 20 supervisory operations is being provided.

In addition to the supervisory relay equipment, interposing relays are located at the remotely controlled stations. They relay the control of operations from the supervisory relay equipments to the power-control circuits of the circuit breakers and other apparatus remotely controlled. They close the same circuits ordinarily closed by hand-operated control switches in manually-operated substations.

House Transformer Banks

Connected to the 12-kv bus in each substation by oil circuit breakers in all respects similar to those for the main transformers are two three-phase banks of transformers supplying 240/120 volts for lighting and 240-volts for battery-charging sets, motors on the rectifier heat exchangers and vacuum pumps, and for the auxiliaries that actuate the voltage-regulating control grids of the rectifier anodes.

At the San Francisco substation, each of the two 12-kv house-bank breakers is used also to control a three-phase circuit that will supply the San Francisco terminal station with power and light. Two three-conductor rubber-insulated metal-armored self-supporting cables will be run overhead on the catenary bridges; the cable supports are special castings, designed to fit the curvature of the cables at the point of support. One of the provisions of the power schedule for electric railways permits this incidental use of energy for facilities directly associated with the operation of the railway; it will result in a substantial reduction in the cost of light and power at the terminal from the cost if energy had been supplied under commercial rate schedules.

At the Mole substation a three-phase open-wire circuit will be connected to the load side of one of the 12-kv house-bank breakers. It will supply energy for lights and motors in the car-equipment-inspection buildings of the Key and Interurban at the east end of the storage yard.

Contact System

The bridge railroad will consist of 32 miles of electrified tracks, divided into approximately 20 miles of main-line tracks and 12 miles of set-out and storage tracks. The latter are on the Key Mole, the set-out tracks being used for making up or setting out trains, or sections thereof for the peak periods, and the storage tracks being used for the storage and inspection of cars and trains at other than peak periods.

The overhead, or 1,300-volt, contact system, for the 14 miles of main line tracks will be what is known as compound catenary, which consists of a main messenger, an intermediate messenger, and two contact wires. In order to insure that trouble on the overhead on one track would not affect operation over the other, the two are maintained as entirely separate feeder systems between the San Francisco substation and the East End tie station, which is the point (at or near 26th Street in Oakland) where they join the existing Interurban contact system, with these exceptions: at the San Francisco substation, at the Yerba Buena Island tie station, at the Mole substation, and at the East End tie station, the contact system in each track is sectionalized, and each side is connected separately to a common bus through a high-speed circuit breaker, which to that extent permits paralleling of the eastbound and westbound trolleys.

It was known, of course, that each of the two tracks which form a common return for both 1,300-volt and 625-volt propulsion currents would consist of two 90-pound running rails and two 90-pound guard rails having a conductivity equal to about 3,500,000 circular mils of copper.

An analysis of the train diagram and the load curve enabled the engineers to determine the traffic condition that would create the maximum voltage drop, which had been limited by agreement to 75 volts for the 625-volt system and approximately 155 volts for the 1,300-volt system. The copper cross section required for the positive side of the circuit was about 1,000,000 circular mils. This was disposed of in the compound catenary as follows: The main messenger is a 500,000 circular-mil 37-strand hard-drawn-copper cable; the intermediate messenger is a number 4/0 19-strand hard-drawn-copper cable, and the contact wires are two number 4/0 grooved bronze of 80 per cent conductivity. The messenger is supported from the overhead structure by two $7^1/_2$-inch ball-and-socket-type suspension insulators in series, the spans varying in length from 56 feet with a four-inch sag on the bridge to spans of 240 feet with a 60-inch sag in the East Bay yard area.

The intermediate messenger is suspended from the main messenger by hangers spaced 15 feet, and the two contact wires are clipped to the intermediate alternately at $7^1/_2$-foot intervals. All fittings, suspensions, and hangers are bronze.

For 4,000 feet east from the San Francisco substation, and for 3,100 feet west from the Mole substation, a 500,000 circular-mil cable supplements the 500,000 circular-mil messenger. Its principal purpose is not so much to reduce the voltage drop as to increase the current-carrying capacity of the contact system on the heavy grades.

In the larger part of the storage yard, the contact system for the Key and the Interurban tracks will consist of a $^3/_8$-inch, 13-per-cent-bronze messenger and a 4/0 copper contact wire.

The contact systems over the storage yard tracks of both the Interurban and the Key, are isolated electrically from the main-line tracks, and are fed directly from the 1,300-volt and 625-volt busses at Mole substation, through individual circuit breakers.

On main tracks, the Key will use a 150-pound third rail for its contact system. The steel in this rail has a low carbon content, and its conductivity is equivalent to 2,730,000-circular mils of copper. The ratio of resistance of steel to that of copper is about 6.88; for running rails, with standard carbon content, this ratio is about 12. Some 55-pound third rail is used in the San Francisco terminal area, and in the Key's storage yard. The two third rails are tied together midway between San Francisco substation and the Island substation, and midway between the latter and the Mole substation, by circuit breakers of the heavy duty latched-in trip-free air-break type; they close electrically on line voltage, and trip either on overload or by remote control. For a distance of about 4,000 feet east from the San Francisco substation, the third rail is supplemented by a 1,000,000-circular-mil feeder, to decrease the voltage drop.

Cars and Equipment

When the program of rehabilitating its equipment is completed, the Key will have a total of 88 articulated units, of which 23 will be entirely new; 25 will be made up from present long and short center entrance cars, and the other 40 will have bodies reconstructed for articulation and modernized from the present vestibule type cars. Every unit is equipped with four motors and, in addition to the

(Concluded on page 383)

Tensors—in "Words of One Syllable"

By H. H. SKILLING
MEMBER AIEE

Tensor analysis continues to interest—and to perplex—many electrical engineers. In several previous articles and papers, including a series in the first three issues of ELECTRICAL ENGINEERING for 1938, efforts have been made to explain tensor methods and their great power and usefulness. In a hopeful effort to broaden the general understanding of the fundamentals of tensor analysis and their relation to more commonly used mathematical methods, this further discussion of the subject is published. In trying to get as close as possible to fundamentals the author of this article tells the story of tensors, figuratively, in words of one syllable, and suggests a course of study to be used as a stepping stone to a working knowledge of tensor analysis.

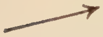
THIS IS a desperate adventure. It is an attempt to discuss tensor analysis without the use of any unusual notation and with no symbols other than ordinary algebraic ones. Tensor analysis is a new concept, and it is enough (for an introduction) that the idea should be new without having new notation to cloud the issue.

Of course, it is the peculiar notation that makes tensor analysis so compact, and therefore so useful. But all I hope is to give an idea of what tensor analysis is about. Then, later on, I will mention some books that will help anyone who wishes a working knowledge of the subject.

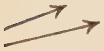
The new concept of tensor analysis is this: The electrical engineer thinking in terms of tensors thinks of all the currents in a network as a single entity. Instead of thinking, for instance, of *current in one wire*, and then of *current in another wire*, and then of *current in a third wire*, he thinks of a single idea—CURRENTS IN A POLYPHASE SYSTEM—and he uses just one symbol to express that whole idea. He writes I, and means ALL THE CURRENTS IN THE SYSTEM.

Another single idea is VOLTAGES IN A POLYPHASE SYSTEM, thinking not of several separate voltages, but of just one entity, and using just one symbol such as E. He then can write equations in terms of those symbols, although of course when the time comes to get a numerical answer it is necessary to use numerical values of the individual currents and voltages. The advantage of the tensor concept is in transformations that can be made in the symbolic form.

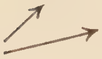
Tensors have been used by physicists since the end of the last century for a specific type of problem. An example is the stress-strain relationship of an elastic material. If the stress is in some direction



the strain may be in that direction also:



But in a nonisotropic substance, such as a crystal, it may be in a different direction:



As an extremely simple example consider two long springs of different stiffness arranged at right angles, as in figure 1, the distant ends being firmly fixed, but the common point being movable when force is applied. Let us now arbitrarily assume a pair of co-ordinate axes X and Y along the lines of the springs, so that when the springs are not stretched the point at which they are fastened together is at the origin.

If force is applied along the X axis, only one spring is stretched, and we find by measuring that force and displacement are proportional:

$$F_x = k_1 S_x$$

where

F_x is *force in the x direction.*
S_x is *the x component of displacement.*
k_1 is a factor of proportionality.

Then, removing that force and applying force along the Y axis, we find

$$F_y = k_2 S_y$$

with a similar meaning for F_y and S_y, and with k_2 measuring the stiffness of the vertical spring.

If a force is not along either axis, it must be divided into components, so we will say that any general force F is made up of two parts, one in the x direction, and one in the y direction:

$$F = \textit{in the x direction, } F_x + \textit{in the y direction, } F_y$$

Then, since we know the values of F_x and F_y, this can be expanded to:

$$\begin{aligned} F &= \textit{in the x direction, } k_1 \textit{ times the x component of } S + \\ &\quad \textit{in the y direction, } k_2 \textit{ times the y component of } S \\ &= k_1 \textit{ times, in the x direction, the x component of } S + \\ &\quad k_2 \textit{ times, in the y direction, the y component of } S \end{aligned}$$

The peculiar order of words in this statement is for a reason

---

Written especially for ELECTRICAL ENGINEERING, based upon an address presented before the AIEE San Francisco Section, March 11, 1938.

H. H. SKILLING is assistant professor of electrical engineering at Stanford University, Calif., from which he received the degrees of bachelor of arts (1926), engineer in electrical engineering (1927), and doctor of philosophy (1931). In 1930 he was awarded the master of science degree by Massachusetts Institute of Technology. From 1927 until 1929 Doctor Skilling was employed in the construction department of the Southern California Edison Company. Since 1929, except for a period of graduate study at MIT, he has been a member of the electrical-engineering faculty of Stanford University. He has presented several papers on power transmission before the Institute.

1. For all numbered references, see list at end of paper.

that now appears. For to be quite clear this statement requires a good deal of writing, and we will save time and trouble by introducing the following abbreviations: We will let i mean "*in the x direction,*" let j mean "*in the y direction,*" let $i\cdot$ mean "*the x component of,*" and let $j\cdot$ mean "*the y component of.*" Using these abbreviations equation for force just given becomes

$$F = k_1ii\cdot S + k_2jj\cdot S$$

As this is read aloud, reading in full the meanings of i and $i\cdot$ and j and $j\cdot$ it sounds just like the long equation above. Sometimes, for convenience, this is written

$$F = (k_1ii + k_2jj)\cdot S$$

and it means exactly the same. Then the quantity in parentheses is called a tensor. It is a sort of factor of proportionality that relates two vectors; but it is not a mere arithmetic factor, because it relates them in angle as well as magnitude. But this is a very simple and highly specialized tensor.

In the more general case of the same problem the arbitrary axes do not lie along the springs, but in some other directions, as shown in figure 2. Then as a force is applied along the X axis, displacement will not be along the X axis (we assumed springs of different stiffness) but will have both X and Y components. Experimental data take this form:

$$F_x = k_{11}S_x + k_{12}S_y$$

and

$$F_y = k_{21}S_x + k_{22}S_y$$

The total force is made up of these components, so

F = *in the x direction*, F_x + *in the y direction*, F_y

If the values of F_x and F_y are substituted, this becomes:

F = *in the x direction*, k_{11} times *the x component of S* +
also *in the x direction*, k_{12} times *the y component of S* +
in the y direction, k_{21} times *the x component of S* +
also *in the y direction*, k_{22} times *the y component of S*

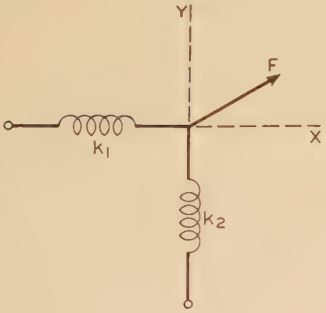


Figure 1. Two springs of unequal stiffness, to which a force is applied

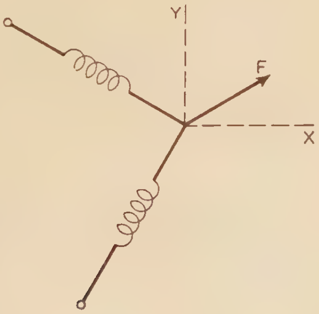


Figure 2. The same springs as in figure 1, but rotated relative to the co-ordinate axes

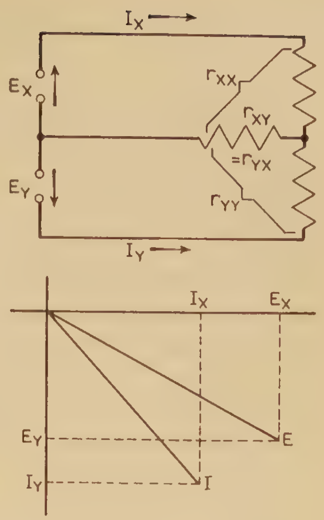


Figure 3. (Top) a network of two circuits; (bottom) the corresponding two-dimensional voltage and current tensors

Using the same abbreviations, we will know exactly what is meant when this is written as

$$F = (k_{11}ii + k_{12}ij + k_{21}ji + k_{22}jj)\cdot S$$

Again the quantity in parentheses is a tensor. Note that in the previous special case k_{12} and k_{21} were zero because a force in the x direction did not produce any displacement in the y direction, and vice versa. Again this stress-strain tensor is a kind of two-dimensional factor of proportionality.

For purposes of computation it is often useful to write a tensor in its so-called "matrix" form. The tensor just discovered is written

$$\begin{Vmatrix} k_{11} & k_{12} \\ k_{21} & k_{22} \end{Vmatrix}$$

and the meaning given by the i's and j's in the force equation is to be attached to the corresponding k's in the matrix merely because of the *positions* those symbols occupy in the matrix array.

A vector, such as F, is also a tensor, and the matrix is

$$\begin{Vmatrix} F_x \\ F_y \end{Vmatrix}$$

This force tensor is called, for obvious reasons, a tensor of rank 1, and the stress-strain tensor is of rank 2.

Now let us see how voltages, currents, and impedances in electric networks can be called tensors. To make it quite clear that the tensors and vectors in the following discussion have absolutely nothing to do with the complex quantities that are commonly miscalled "vectors" in the theory of alternating current, we will discuss *direct current* only.

Solving a Simple Problem With Tensors

There is, let us say, a simple network as in figure 3. Current in the upper circuit is I_x, and in the lower circuit I_y. Voltage applied in the upper circuit is E_x and in the lower circuit E_y. (This might represent a three-wire distribution system.) Now draw a pair of co-ordinate axes. Distances on these axes represent not force or distance, but voltage and current. Along one axis lay off a distance to represent E_x, and on the other a distance to represent E_y. Those two values may be represented (by projection) by a single point E. This single point will represent *both* voltages. So we have the idea of a single entity (a tensor if you like) to represent plural voltages.

Next, lay off I_x along the same axis as E_x, and I_y along the other axis with E_y. Then represent both currents by the single point I. Let us now solve the following problem: Given E (which is two voltages) find I (which is two currents).

The relation between E and I is the impedance tensor of the network. To see the occasion for using a tensor, write Kirchoff's second law for the circuits:

$$E_x = r_{xx}I_x + r_{xy}I_y$$
$$E_y = r_{yx}I_x + r_{yy}I_y$$

The resistances in these equations are identified in figure 3. Of course, r_{xy} and r_{yx} are the same identical resistance. Now we may say that E, the tensor, is made up of two parts, one in the x direction and one in the y direction:

$$E = \textit{in the x direction, } E_x + \textit{in the y direction, } E_y$$

Also, it is clear from figure 3 that

$$I_x = \textit{the x component of } I$$

and

$$I_y = \textit{the y component of } I$$

Substituting these into the statements of Kirchoff's law, and the resulting values of E_x and E_y into the equation for E,

$$\begin{aligned} E = {} & \textit{in the x direction, } r_{xx} \text{ times } \textit{the x component of } I + \\ & \text{also } \textit{in the x direction, } r_{xy} \text{ times } \textit{the y component of } I + \\ & \textit{in the y direction, } r_{yx} \text{ times } \textit{the x component of } I + \\ & \text{also } \textit{in the y direction, } r_{yy} \text{ times } \textit{the y component of } I. \end{aligned}$$

Now this voltage-current equation is exactly similar to the stress-strain equation that appeared previously, and using the same abbreviations,

$$E = (r_{xx}ii + r_{xy}ij + r_{yx}ji + r_{yy}jj)\cdot I$$

In this way a tensor appears. Understanding that we mean this same thing, it saves writing to say

$$E = R\cdot I$$

Remember that E is two voltages, and I is two currents, and R is all of the resistances of both circuits: This is a tensor equation. (In true tensor notation certain subscripts and superscripts would be attached, but we do not need them here.)

It is quite possible for current and voltage to be alternating, and for each circuit element to be an impedance, with inductance and capacitance as well as resistance. Then

$$E = Z\cdot I = (z_{xx}ii + z_{xy}ij + z_{yx}ji + z_{yy}jj)\cdot I$$

Each current, each voltage, and all four impedances are complex quantities in such a case. Note that z_{xx} and z_{yy} are *self-* impedances, and z_{xy} and z_{yx} are *mutual* impedances.

Now, how may $E = R\cdot I$ be solved to find the currents? Formally,

$$I = \frac{1}{R}\cdot E$$

which is all right if we know what $1/R$ means. It is the reciprocal of the tensor R, and it is itself a tensor of the form

$$\frac{1}{R} = (g_{xx}ii + g_{xy}ij + g_{yx}ji + g_{yy}jj)$$

That this is correct may be proved by writing Kirchoff's law in terms of admittances instead of impedances. Call this new tensor G. Then

$$I = G\cdot E$$

Fortunately we are provided with a rule which makes it possible to compute the G tensor, if the R tensor is known. It is the rule for finding a reciprocal. It is: $g_{mn} = A_{nm}/D$, where D is the determinant

$$\begin{vmatrix} r_{xx} & r_{xy} \\ r_{yx} & r_{yy} \end{vmatrix}$$

and A_{nm} is the cofactor of r_{nm}. If you don't understand the language of this statement, never mind. The important thing is that the g's can be computed, if the r's are known.

The next question that arises is, what is the product of two tensors such as G and E? To find out, we write them out fully as

$$I = (g_{xx}ii + g_{xy}ij + g_{yx}ji + g_{yy}jj)\cdot(iE_x + jE_y)$$

and multiply, algebraically, term by term. When the product is written out, a good many of the terms contain a combination of symbols such as $i\cdot j$; since this means "*the x component of something that is entirely in the y direction*" all such terms ($i\cdot j$ and $j\cdot i$) are zero. Other terms contain $i\cdot i$, which means "*the x component of something in the x direction,*" and the combinations of symbols $i\cdot i$ and $j\cdot j$ are therefore merely unity. When these simplifications are made,

$$I = i(g_{xx}E_x + g_{xy}E_y) + j(g_{yx}E_x + g_{yy}E_y)$$

so that the two currents in the two circuits, the two components of I, are

$$I_x = g_{xx}E_x + g_{xy}E_y$$

and

$$I_y = g_{yx}E_x + g_{yy}E_y$$

That concludes this particular problem, for we have found the currents that we set out to find.

How Does It Work Numerically?

Let us give numerical values to our example and see how it works. Let us apply direct voltage in the following amounts:

$E_x = 100$ volts $\qquad E_y = -50$ volts

The negative sign of E_y merely means that it is in a direction opposite to the arrow in figure 3. Let us assume resistances:

$$r_{xx} = 6 \text{ ohms} \qquad r_{yy} = 8 \text{ ohms} \qquad r_{xy} = r_{yx} = 2 \text{ ohms}$$

Then the matrix of the resistance tensor is

$$\begin{Vmatrix} 6 & 2 \\ 2 & 8 \end{Vmatrix}$$

The determinant needed to find G is

$$\begin{vmatrix} 6 & 2 \\ 2 & 8 \end{vmatrix} = 48 - 4 = 44$$

According to the rule for finding a reciprocal tensor,

$$G = \frac{1}{44} \begin{Vmatrix} 8 & -2 \\ -2 & 6 \end{Vmatrix}$$

The voltage in matrix form is

$$E = \begin{Vmatrix} 100 \\ -50 \end{Vmatrix}$$

and since $I = G \cdot E$ we have

$$I = \frac{1}{44} \begin{Vmatrix} 8 & -2 \\ -2 & 6 \end{Vmatrix} \cdot \begin{Vmatrix} 100 \\ -50 \end{Vmatrix}$$

When this is multiplied out (according to the foregoing discussion of multiplication, or by a simple general rule) the result is

$$I = \frac{1}{44} \begin{Vmatrix} 800+100 \\ -200-300 \end{Vmatrix} = \frac{1}{44} \begin{Vmatrix} 900 \\ 500 \end{Vmatrix} = \begin{Vmatrix} 20.4 \\ -11.4 \end{Vmatrix}$$

This tells us that $I_x = 20.4$ amperes and $I_y = -11.4$ amperes (the minus sign means that current flows against the arrow in the circuit diagram). We have found the desired numerical answer.

Now I will give you a problem to solve. To what electric network does the first simple arrangement of springs correspond? When you have found the answer you will see why a change of co-ordinate axes in a network problem is equivalent to reconnecting the elements of the network.

Now a simple problem has been solved by tensor analysis. The labor required, after the method is understood, is probably less than that for more usual solutions of this problem. But the real value of tensors is in far more difficult problems. A three-phase system with unequal impedances in the three phases and several unbalanced loads or unsymmetrical faults is an example of a more suitable problem for use of tensor methods. When a problem concerning three-phase circuits is to be solved the tensors used are in three dimensions, for there are three currents and three voltages, and the impedances and admittances are dyadics; a dyadic is a three-dimensional second-rank tensor. Sah's work deals with this kind of problem.[1,2] When there are more than three interrelated currents and voltages there must be correspondingly more than three dimensions, and this is possible mathematically although it is hard to draw on paper. Kron discusses multidimensional tensors.[4]

Building a Foundation for Tensor Analysis

I hope this discussion will not be too much criticized because it is mathematically inexact. That is admitted. It is intended merely to introduce an idea. It is not even a beginning for one who wishes to master the technique of tensor or dyadic analysis. One person who read this article in manuscript form protested that I have "used both vector analysis and matrix algebra without letting the reader know it!" If I have been successful in doing so (for I admit that I tried) it shows two things: first, that vector analysis and matrix algebra are not at all to be feared, and second, that they are absolutely essential to tensors. One or the other or, preferably, both, must be a foundation for the study of tensors.

There does not seem to be any one book perfectly adapted to the needs of the electrical engineer who wants to use tensor analysis in network problems. However, a book is promised by Sah[13] and it will be available soon. It can be studied, without preparation, by anyone with a knowledge of calculus, for the first chapters are introductory and all unusual symbols and operations are carefully defined. It is probably the best starting point for a study of the subject.

Sah refers to Gibbs-Wilson; this is the classic treatise on dyadics, but it contains much that has no immediate application and does not employ the modern developments of notation. A more satisfactory reference with the same point of view is Wills.[11] Wills is more to the point, and a great advantage is that he uses notation that carries one painlessly into a study of general tensors. Do not be misled by the fact that only the last chapter in Wills' book is entitled "Tensor Theory," for you learn quite a good deal about tensors in all the last half of the book.

These textbooks introduce the reader to tensors through the use of vectors and the physical interpretation of dimensions as space, just as in the opening pages of this article. There is no necessity for the electrical engineer to make such an interpretation, for he deals with circuits and not dimensions in space at all. So if you do not like the physical concept, but enjoy your mathematics pure, the subject may be approached through what the mathematician calls theory of groups. An excellent little book with this viewpoint is the one by Sheppard.[12] Even if you read the other books first, read this one also for the sake of the different point of view and the concise treatment.

It has been mentioned that the application of tensor analysis to electric circuit theory does not use tensors in the same sense that the physicist knows tensors, although the mathematics is the same. If you speak of tensors to a physicist he thinks of something like the stress-strain problem with springs, but applied throughout a field instead of just at a point, and extended from 2 to n dimensions. (In Einstein's general relativity, n is 4.) It merely happens that the equations of circuit theory are sets of linear equations for which the solution can be expressed in tensor notation. But the solution can also be expressed in other ways. Electrical engineers are playing with quite an assortment of mathematical tools at the present time—tensors, sets, dyadics, matrices. These various tools are more or less similar, more or less overlapping. Take your choice.

References

The following have been published in Electrical Engineering:

1. Dyadic Algebra Applied to 3-Phase Circuits, **A. Pen-Tung Sah.** Volume 55, August 1936, pages 876–82.

2. Complex Vectors in 3-Phase Circuits, **A. Pen-Tung Sah.** Volume 55, December 1936, pages 1356–64.

3. The Tensor—A New Engineering Tool, **A. Boyajian.** Volume 55, August 1936, pages 856–62.

4. Tensor Analysis of Multielectrode-Tube Circuits, **Gabriel Kron.** Volume 55, November 1936, pages 1220–42.

5. Tensor Algebra in Transformer Circuits, **L. V. Bewley.** Volume 55, November 1936, pages 1214–19.

6. Discussion of papers by Sah (page 610) and of Boyajian, Bewley, and Kron (page 614), volume 56, May 1937.

7. Matrices in Engineering, **Louis A. Pipes.** Volume 56, September 1937, pages 1177–90.

8. What Is Tensor Analysis? **Banesh Hoffmann.** Volume 57, January 1938, pages 3–9; February 1938, pages 61–6; March 1938, pages 108–09.

9. The Properties of Three-Phase Systems Deduced With the Aid of Matrices, **M. B. Reed.** Transactions section, volume 56, February 1938, pages 74–7.

The following are books:

10. Gibb's Vector Analysis, **E. B. Wilson.** Charles Scribner's Sons, New York, 1901 (436 pages).

11. Vector Analysis With an Introduction to Tensor Analysis, **A. P. Wills.** Prentice-Hall, Inc., New York, 1931 (285 pages).

12. From Determinant to Tensor, **W. F. Sheppard.** Oxford University Press, London, 1923 (127 pages).

13. Dyadic Algebra and Three-Phase Circuits, **A. Pen-Tung Sah.** International Textbook Company, Scranton, Pa., in press.

Noise Specifications for Power Transformers

AT A CONFERENCE on sound and vibration measurement held during the 1938 AIEE winter convention, A. P. Fugill (A'24, M'30), The Detroit Edison Company, Detroit, Mich., described a series of investigations of noise measurement conducted by that company. The company now has issued a specification describing standard methods of power-transformer noise measurement; the instructions are based upon American Standards Association tentative standards *Z*24.1 (Acoustical Terminology, 1936), *Z*24.2 (Noise Measurement, 1936), *Z*24.3 (Sound Level Meters, 1936), and the proposed AIEE Test Code for Apparatus Noise Measurement, which was issued in 1937. Transformer purchase specifications of the company now include a specification of tolerable noise level, and the company's specification is used as a basis for testing the units after delivery.

The Detroit Edison Company has used a sound-level meter for the measurement of noise from electrical equipment for more than five years. Although the investigations have included some measurement of the noise from mechanical drives, motors, fans, induction regulators, and miscellaneous equipment, most of the work has been concentrated on the measurement of noise from substation transformers, because they are most likely to be located outdoors in residential districts, where their inherent noise may be objectionable.

Altogether Detroit Edison Company engineers have measured the noise from about 175 transformers ranging in size from 100 to 6,000 kva. Both single-phase and three-phase units were included, practically all for step-down service from 24 kv to 4,800 volts. Although most of the transformers were self-cooled units, the tank size, shape, proportions, and construction varied widely; some tanks being corrugated, others being smooth with cooling surface in the form of flat tubes, round tubes, or radiators. Most of the original measurements were made outdoors where the effects of reflections from acoustical obstacles were at a minimum. The measurement of noise outdoors soon appeared to have several limitations. The noise from sources other than power transformers was difficult to control, because any accessible location was likely to be near a well-traveled highway, with consequent traffic noise. In a residential neighborhood the normal noises, such as shouting children, barking dogs, and chattering birds, often were louder than the noise from the transformer. At night crickets and other nocturnal beings frequently caused interference.

These inconveniences, and others, seemed to indicate the desirability of making noise measurements indoors, but indoor measurements involve reflections from nearby walls and other surfaces. The Detroit Edison Company wanted to make many of its measurements in a test cage located in a maintenance warehouse with plenty of headroom but limited floor space. In order to determine what effect reflecting surfaces might have on test results, the investigators arranged a series of measurements of the noise from a single-phase 500-kva self-cooled 24,000/4,800-volt transformer. Two sets of measurements were taken outdoors: one with the transformer 100 feet away from a building wall; the other with it 50 feet away. The transformer then was moved inside the warehouse, and similar measurements were taken at three positions. In the first of these positions, the transformer radiating tubes were about 11 feet from the closest obstruction in any direction. In the second position the transformer was in a corner formed by a building wall and a loading

Table I. Essential Results of a Series of Measurements of Noise From Power Transformers

	Average of 20 Readings (Decibels) With Microphone:			
	6 Inches From Transformer		3 Feet From Transformer	
Location of Transformer	3 Feet High	6 Feet High	3 Feet High	6 Feet High
Outdoors 100 feet from building wall	52.5	52.6	49.5	48.8
Outdoors 50 feet from building wall	53.5	51.6	49.7	49.4
Average	53.0	52.1	49.6	49.1
Indoors 11 feet from building wall	53.0	50.2	50.4	48.4
Indoors 6 feet from building wall	52.3	51.0	50.5	48.3
Indoors $2\frac{1}{2}$ feet from building wall	54.3	52.0	51.0	47.9

dock three feet high. The distance from the transformer radiating tubes to the wall and to the dock was six feet, with no interference within 16 feet in the other two directions. In the third position the transformer was two and one-half feet away from a building wall on one side, the other side being clear. The essential results obtained from this series of tests are tabulated in table I. The results indicate that the difference between each set of readings indoors and the average of the two readings taken outdoors ranges from +1.3 to −1.9 decibels in a random manner. Repeated measurements under identical conditions provide somewhat better agreement, a difference of one decibel being considered satisfactory. Nevertheless, the errors seem to be relatively small, even under adverse conditions. In general a clear distance of ten feet on all sides and above the transformer is recommended.

The main difficulty in the measurement of noise is to obtain a sufficiently quiet ambient noise level. The ambient noise should be at least six decibels, and preferably ten decibels below the apparatus noise. If tests for noise are made after the regular shop working hours, little difficulty is experienced as long as the equipment noise is above 45 or perhaps 40 decibels. This will take care of all power transformers as built today.

The method by which the noise values for these specifications were obtained may be used in setting up values for any electrical equipment. The first step is to specify the voltage, load, speed, method of mounting, and such factors which affect the inherent equipment noise. Since one reading, no matter where located, is not sufficient measure of the noise from any equipment of large size, it is also necessary to determine the location of the microphone and the number of readings required to indicate properly the average noise level of the equipment.

The second step is to determine the noise level on existing equipment similar to that for which the noise is to be specified by measurement according to the code developed as indicated in a previous paragraph.

The third step is to determine which of the units measures are satisfactory for the purpose intended. This can be done only on the basis of past experience, tempered by good judgment. Care should be taken not to specify equipment much quieter than standard equipment unless there is really a need for it, because extra-quiet equipment invariably will be more expensive.

Transmission Theory of Spherical Waves

ESSENTIAL transmission properties of spherical waves are formulated in terms of familiar engineering concepts in this paper.* Such a formulation places the subject of spherical waves within bounds of transmission-line theory, thus co-ordinating two apparently distinct subjects; moreover, this plan facilitates the solution of some shielding problems and emphasizes the physical aspects of shielding. The general formulas for shielding in terms of impedances for spherical waves are derived.

Mathematically this paper is brief and limited mostly to conclusions. It contains successive sections on waves emitted by an electric current element, waves emitted by an infinitely small electric current loop, transverse magnetic spherical waves, transverse electric spherical waves, and transverse electromagnetic spherical waves.

---

* Abstract of 1938 AIEE summer convention paper number 38-74, by S. A. Schelkunoff (M'34), which will be published in full in TRANSACTIONS.

Electrification of the Bay-Bridge Railway

(*Continued from page 377*)

pantograph for current collection, will have four third-rail shoes that will be automatically raised or lowered by approach or exit folding ramps at the ends of the third rail territory, or where the third rail changes from one side of the track to the other.

The Interurban has 145 units of equipment, of which 85 are now motor cars, 21 are operating trailers (cars having control equipment at either end, which permits their operation at the head end of a train), and 39 are nonoperating trailers. Bridge operation makes necessary a larger proportion of motor cars to trailer cars than now prevails; first, more trains are required because of the increased mileage; and second, the ratio of motors to trailers in a train will be greater due to the heavy grades on the bridge.

Provision is being made to convert six operating and four nonoperating trailers into motor cars, the net result being 95 motors, 15 operating trailers, and 35 nonoperating trailers.

All cars are to be equipped with automatic couplers, new and higher gates on roller bearings, window stops, emergency lights, side signs designating route, and additional devices to accelerate application of the air brakes on the bridge grades and make shorter signal sections possible. Motors and trailers will be equipped further with cab signals and automatic speed control, sand boxes and sanders, and destination signs at each end of the roof.

The Sacramento-Northern is making corresponding changes in its equipments, to adapt them for bridge operation.

Signals

Each track is equipped for operation under cab signal indications in one direction only except at San Francisco terminal interlocking, where movements can be made in both directions. The cab signal indicator, which is located in front of the engineman, is equipped to give six visual illuminated signals. When leaving automatic train control tracks, equipment is provided to cut out speed control and cab signals automatically, and vice versa. In train control territory, the train cannot be operated unless the automatic speed control and cab signal system are in service.

The various cab signal lamps are lighted in response to electrical impulses impressed on the 100-cycle track circuit and picked up inductively by two receiver coils mounted on the truck about six inches above each rail.

Our Scientific Era—The Historical Point of View

By ALFRED STILL
FELLOW AIEE

Science of a few centuries ago, far from positivistic, nevertheless was dogmatic, and was based upon superstition, tradition, and mysticism. But by the end of the Middle Ages men were losing their compliant faith in tradition, and the scientist turned to material observation and experimentation for the explanation of natural phenomena. The consequent search for immutable laws again introduced in science an element of dogma, which remained effective until about the end of the 19th century. During the present era, scientific thought seems to be turning away from the realistic approach, because the shattering of seemingly well-established laws has made men doubt their own senses. The author of this article stands in the middle of this era, looks at science in retrospect and in prospect, advances some provocative riddles, but lets the reader contrive to find his own answers.

THERE is a growing belief that the modern physicist has been forging ahead too fast; or, in vulgar parlance, that "he has bitten off more than he can chew." If this belief existed only in the minds of those who cannot understand the bewildering and ever-changing theories which encourage the scientist in his endless investigations, it would not be disturbing. But there are many indications that the scientist himself—especially the mathematical physicist—is beginning to wonder whither he is drifting, and why the phenomena of nature do not adapt themselves more perfectly to the particular scheme of things which happens to be nearest to his heart's desire. This is discouraging for Youth whose landmarks are no longer stationary and whose aspirations are less exalted than when he relied, with unlimited confidence, upon the authority of his teachers.

The method of science is cumulative. We discover what were formerly thought to be unalterable truths, and we invent what we call laws of nature. Then we try to define them. For this purpose we use either the symbols of the mathematician, which is the easier way; or, if we are exceptionally clever, we use words. This pleases the layman because he thinks he will at last be able to understand what the scientist has to tell him. But he deceives himself. He has either forgotten, or else he never knew, that words also are symbols, differing in form, but not in essence, from the Greek letters and the funny curls and pothooks with which the mathematician masks his deeper thoughts. The scientist makes a record of his findings, thus adding continually to our store of admitted facts, and providing material for the writers of history. The reader of such history will learn how almost countless hypotheses have been created, cherished by their zealous exponents, and discredited by the inventors of new hypotheses. The latest theory is often the most pleasing, and as such is helpful for the time being in stimulating the scientist to further efforts. But there is no finality; nothing but an addition to our rather cumbersome store of scientific data, and a change in our appreciation of the world we live in. The scientist and the student of science are in the stream, and perhaps of it; but they have not "arrived"; there is, indeed, no conclusive evidence that they are arriving; merely a continual change in scenery, with things of stirring interest happening all the time.

Yet it is for these reasons—for there seem to be no others—that an optimistic, if not very thoughtful, minority has believed that the progress of society along scientific lines must ultimately lead to a better, or less imperfect, civilization.

Many of the older theories appear to us now, in the light of our riper knowledge, as very weak, unsatisfying, and even foolish. What adequate reason, derived from history, can possibly be advanced in support of the view that our present imposing scaffolding of mathematical symbols based on *numbers* will support us any more firmly than the crumbling theories of the past, based on the logic and common sense of their period?

The philosophers of our age have almost succeeded in convincing the physicist that no theory, however attractive, which he may have to offer, will ever shatter the screen of *appearance* and bring us face to face with *reality*. There are those who believe that such views are discouraging and should not be tolerated. Why? They cannot tell us; and since they are also quite incapable of defining the thing which they call reality, there is surely no occasion to weep over the milk of nebulous perfection which has never been spilled.

It is indeed doubtful that the attainment of perfection and the discovery of a world of reality would satisfy our longings or appease our restless souls. The idea of finality is distasteful to many, and science itself, which is a creation of man's intellect, is merely a process by which nature may be studied. It makes no promise of an ultimate complete understanding of nature, neither is there anything to suggest that what is discovered by applying its method is true. The scientist is beginning to understand this, and usually expects no other reward than the contentment, if not the joy, which he experiences in the pursuit of knowledge.

Written especially for ELECTRICAL ENGINEERING.

ALFRED STILL, a native of Inchbrook, England, was educated at the Collège de Dieppe (France) and Finsbury College (England) before becoming associated with the consulting engineering firm of Fawcus and Cowan, Chester, England, in 1889. In 1891 he became chief electrical designer for the Manchester Edison and Swan Company, where he remained eight years. From 1899 until 1911 he was chief engineer and managing director of Cowans, Limited. In the latter year he went to Canada to become chief electrical engineer to the Lake Superior Corporation, Sault Ste. Marie, Ont. Two years later he was appointed to the electrical-engineering faculty of Purdue University, where he remained in charge of the courses in electrical design until his retirement in 1934. He has contributed freely to the technical press in the United States and England, and is the author of several widely used textbooks on electrical engineering.

About one hundred years ago, soon after the discoveries of Michael Faraday were bearing fruit and pointing a new way for the advance of civilization, a period had been reached when the scientist was in the ascendant. He had already been acclaimed by the populace as its new guide and saviour. In physics especially—"the science of the nature of things"—rapid progress was being made. Men were losing faith in tradition and the lingering shibboleths of an effete medievalism. They had begun to realize that the effrontery of their religious leaders had been assumed without justification and was entirely unwarranted; they clamored for something new to worship. They asked the physicist what he proposed to do about it. He gave them the engineer.

And so it was that materialism became rampant. The world of science, which has always been the world of appearance, became also the world of reality. For tired intellects, there is nothing easier than to suppose that whatever seems to be, actually is. The materialistic conception of the universe was convenient to the scientist of the 19th century, and as a philosophy it was welcomed by the people. It was a mode of thought which strengthened the growing tendency to regard the engineer's application of science to practical purposes as the supreme contribution of the physicist. Pure science might interest the highbrows; but applied science was the meat of the people. It gave them not only power over nature, but also an improved technique in the subjugation of their more stupid brothers. In the belief that they wanted power more than anything else, they looked forward with a childlike eagerness to a scientific millenium.

The scientists of the Victorian period were almost as fatuous as their followers. They had difficulty in realizing that the process of observation and accurate measurement which so admirably fulfilled their expectations was, if not an end in itself, little more than a tool in the hands of experts who, if they were wise, might use it to the advantage of mankind, and if they were foolish, could put it into the hands of intellectual inferiors to be used or abused according to their whim. Writing in 1931, Bertrand Russell said (*The Scientific Outlook*, W. W. Norton and Company, Inc.; page 268): "The new powers that science has given to man can only be wielded safely by those who, whether through the study of history or through their own experience of life, have acquired some reverence for human feelings and some tenderness toward the emotions that give colour to the daily existence of men and women." What, then, are we to conclude? Surely not that these recently acquired powers *are* being wielded safely. But we can always close our eyes to the obvious, and drift. This is, indeed, the conventional thing to do. We may be piling up a stack of troubles for future generations, but we will not have to rehandle them. "Take therefore no thought for the morrow; for the morrow shall take thought for the things of itself. Sufficient unto the day is the evil thereof."

The scientists of the 19th century sought laws that they assumed to be true in a world that they believed to be real. By their attitude of mind, they created what we call the scientific era, in which we move and have our being. But the physicist of today is no longer a materialist. His universe is not made up of lifeless material atoms obeying immutable laws in a three-dimensional space. It is something very different; but of its nature we know very little, because the physicist, who invented it, cannot tell us anything about it. What we *do* know is that he *describes* natural phenomena in terms of mathematical expressions, but no longer attempts to *explain* them. For this temperance he deserves praise; but why he should suppose—as he sometimes does—the elusive something, which he describes mathematically, to be part of ultimate reality, is a mystery which still remains unsolved.

The menial spirit of the Middle Ages had degraded science and sought natural knowledge, not by questioning Nature herself, but by rummaging among the moth-eaten manuscripts of the ancient philosophers. Such science as then existed was in the hands of necromancers, astrologers, alchemists, and physicians.

Then came the scientific awakening. Out of the medieval chaos a new world was being evolved, in which *effect* followed *cause*, and its builders were about to discover that nature is extremely simple, orderly, and sane. All this was disconcerting for the adherents of the old school of thought, and for those whose living depended upon their status quo and the continued support of whatever dogma it was their duty to disseminate. But the materialistic philosophy of the new science could not last. The triumphal progress of its exponents was too splendid and too rapid. They made the foolish mistake of accepting as their due the fulsome plaudits of the populace. They became proud and dictatorial.

The physicist of today is very different from his predecessors of a generation ago. He is not arrogant, he is not didactic, and he is at times so humble as to appear almost painfully diffident. His latest philosophy is tentative and bashful; he is annoyed with the new quantum theory which causes him much uneasiness. There are times when he seems almost abject, particularly when he fawns upon the dogmatists and wonders whether, after all, a sprinkling of superstition may not be helpful in relieving him of his heavy burden of skepticism. But in general he is honest; and this, together with his newly acquired humility renders him trustworthy and likable.

It is clear that the modern scientist is beginning to realize how very far he is from solving the riddle of the universe. He will soon be agreeing with the wise Omar Khayyam, who said: "Those who are endowed with Knowledge and with Virtue, whose profound Wisdom hath made them like Torches to their Disciples,—even these have made no Step outside this Depth of Night: they have babbled of certain Fables—and are withdrawn again to Sleep."

Let us seek a more cheerful note by determining, if possible, what the study of scientific history can do for us. In the first place, there can be little doubt that it enables us to view the present status of our particular branch of knowledge from a more rational point of view than if we knew nothing about the earlier stages of its development. The superficial study of a particular science may tend to make us bumptious and intellectually arrogant, but an understanding of the story of scientific progress should make us humble. And although humility may not be properly appreciated in our rather blatant age, we need not be afraid of it on that account. All great scientists are, and always have been, humble. They are never ashamed to admit that much of what they have discovered they cannot understand. They mix a little philosophy with their science and, by so doing, experience less difficulty than the majority of their contemporaries in remaining completely alive until the day of their death.

Exceptionally gifted persons, including the great physicists, receive little encouragement from a democratic government. The kind of training which its votaries refer to as democratic culture is supposed to be good for the masses of the people, but it makes no pretense of being useful to genius. Democracy does not deny the fact that, in lavishing its resources upon the many, it overrides and neglects the few. When these few happen to be also the best, this policy may be considered unfortunate. Many philosophers have thought so. Plato, whose mood was sometimes ironical, said in his *Republic* that democracy is "a charming form of government, full of variety and disorder, and dispensing equality to equals and unequals alike." Modern critics of our educational system have observed that it does not encourage original thinking and is even antagonistic to genius. Whether or not this is a good feature of the system is largely a matter of opinion. Samuel Butler thought that Providence was helping us to clarify the situation. In his *Strange Notes* he says: "Among all the evidences for the existence of an overruling Providence that I can discover, I see none more convincing than the elaborate and for the most part effectual provision that has been made for the suppression of genius. The more I see of the world, the more necessary I see it to be that by far the greater part of what is written or done should be of so fleeting a character as to take itself away quickly. That is the advantage of the fact that so much of our literature is journalism.

"Schools and colleges are not intended to foster genius and bring it out. Genius is a nuisance, and it is the duty of schools and colleges to abate it by setting genius-traps in its way. They are as the artificial obstructions in a hurdle race—tests of skill and endurance, but in themselves useless. Still, so necessary is it that genius and originality should be abated that, did not academies exist, we should have had to invent them."

Some feel that Butler has overstated the case; others may pride themselves upon detecting a note of flippancy in this debatable passage, and wonder whether its author was entirely serious when he wrote it. But it is almost as difficult to believe this as to suppose that anyone with a sense of humor would have the temerity to write on so grave a subject as the education of the young.

In all seriousness, the teacher, the scientist, and even the philosopher, should heed the fact that, in this our modern age of intellectual enlightenment, Youth expects intelligent answers to the questions it may deign to put. Young people have been told that Reason now rules supreme and that questions are no longer answered by reference to Authority, whether of the living present or the unburied past. The statement is, of course, only partially true; but an attempt is being made to deal honestly with those seeking information. The concession is laudable even if somewhat premature.

We have hardly scratched the surface of the hidden mine of knowledge. The things we thought we knew have been shown to us in a different light, and we are beginning to wonder if we ever knew anything that was worth knowing. What we thought to be absolute knowledge is now seen to be a mere fiction of the imagination. We have a growing respect for the other fellow's point of view because we realize that what we thought was a "law of nature" is little else but the crystallization of our prejudices. In matters outside the sphere of politics and international relations, we are becoming gradually more tolerant.

The scientist still depends upon the evidence of his senses, but he is worried because it does not make sense. He is eager to know, but is dissatisfied with the quality of his knowledge. He feels himself drifting from the positive and complacent attitude of his predecessors, but the things he would like to cling to have no stability and no foundation.

The younger generation is fully alive to the situation. Having, on our advice and with our blessing, lost its old-time respect for authority, Youth expects little of the learned, whose attitude is a confession of their faith, namely, that nothing has ever been done rightly, or known completely, or settled finally. When Youth, in its refreshing eagerness, clamors for reliable information on this or that bewildering mystery of the universe, we of the older generation feel weak and helpless; we are not sufficiently honest to admit the appalling depth of our ignorance; but, rather shamefacedly, we tell of how such and such a thing might be so or so, while, on the other hand, it is believed by others to be this or that; and Youth is left floundering in our intellectual morass. It is in vain that the child asks his father why fire burns, or water freezes; how sunlight reaches the earth, or why rain falls to the ground. Yet these are simple and seemingly inocuous questions. Should the unsatisfied child tread closer to the forbidden borderland and suggest that the picture of his future life, as painted by his devout grandmother, may be founded upon a misconception, what then?

It is a difficult situation, but far from hopeless. The struggle must go on—it will never end. With less fear and more honesty in our hearts, we, who—by having lived longer—have surely picked up a few shreds of wisdom, would have the courage to say: "Son, do not imagine for one moment that the fields of science are exhausted; they are still chock-full of lovely secrets which you have a far better chance of discovering than we ever had. Yes, it is quite true that we know nothing; our assumed superiority was merely a pose which we foolishly enjoyed until we found it to be based upon a fallacy and no longer serviceable. But you, son, having discovered the hollowness of our pretensions, have fewer lessons to learn. We give you our world of appearance, with all its beauty that we have never analyzed, and its many riddles that we have never solved. You are young; you have a lifetime before you. We invite you to seek an answer to these riddles. It will be lots of fun!"

News
Of Institute and Related Activities

Portland Sets New High for Pacific Coast Conventions

SETTING a new all-time high mark for registration at a Pacific Coast convention, the 26th AIEE Pacific Coast convention, held August 9–12, inclusive, at the Multnomah Hotel in Portland, Ore., came to the close of its activities with a total verified registered attendance of 454. An analysis of this attendance, and a comparison with preceding conventions back through 1920, are given in the accompanying tabulations. The principal features in which this year's convention differed from those of earlier years were the selection of convention dates nearly a month earlier than those that have prevailed for several years, and the provision of a technical program having a greater than usual number of sessions and technical papers. One notable characteristic was the relatively large number of family groups that were in attendance as a part of a vacation trip. Another feature, initiated last year at Spokane and repeated this year because of its popularity, was the holding of a session on communication jointly with the Institute of Radio Engineers, who held their convention concurrently in the same hotel.

E. F. Pearson, general convention chairman

Effective in commanding attention for the opening session Tuesday morning, August 9, was the use of a bugler who sounded First Call from in front of convention headquarters on the mezzanine floor overlooking the lobby.

Mayor Carson and President Parker Speak

Presiding at the opening session was L. T. Merwin (A'10, F'33), past chairman (1916–17) of the Portland Section, who was introduced by General Convention Chairman E. F. Pearson, and who in turn introduced the Honorable Joseph K. Carson, mayor of the city of Portland. Warming to his technical audience of some 275 persons, Mayor Carson delivered a vigorous invitation and challenge to engineers to take a more prominent part in civic affairs. He said in part—"we come much nearer to having a 'perfect economy' when we do not try to make one with artificial rules—it cannot be created by government; the function of government is to protect and to encourage those leaders in business and industry who are capable of producing the things the nation needs for its existence and prosperity. We will not have sound prosperity until the scientist, the engineer, and others capable, are given rein to produce . . ."

Introducing "a bit of retrospect," Chairman Merwin recounted briefly some of the historical high lights of the Institute, nationally and locally, to show the scope and trend of development of the Institute and of the electrical industry. He outlined the growing interest that led to the organization of the Portland Section in 1909 as the 23d Section to be organized, and introduced several of the early Section chairmen including O. B. Coldwell (A'03, F'12) 1909–11, F. D. Weber (A'09, M'30) 1911–12, and Paul Lebenbaum (A'04, M'13) 1915–16, now in San Francisco, Calif.

Analysis of Attendance at 1938 Pacific Coast Convention

Classification	Portland	Dist. 9*	Dist. 8	Dist. 10	Misc.	Totals
Members	72	78	56	7	16	229
Men guests	37	18	8	1	6	70
Women guests	45	35	26	6	5	117
Enrolled students	9	15	14	—	—	38
Totals	163	146	104	14	27	454

* Outside of Portland Section territory.

Pacific Coast Convention Attendance—1920–1938

Year	Location	Attendance
1920	Portland, Oregon	251
1921	Salt Lake City, Utah	*
1922	Vancouver, B. C.	235
1923	Del Monte, Calif	252
1924	Pasadena, Calif	363
1925	Seattle, Wash	408
1926	Salt Lake City, Utah	250
1927	Del Monte, Calif	250
1928	Spokane, Wash	250
1929	Santa Monica, Calif	440
1930	Portland, Ore	300
1931	Lake Tahoe, Calif	247
1932	Vancouver, B. C.	300
1933	(No Pacific Coast Convention)	
1934	Salt Lake City, Utah	232
1935	Seattle, Wash	269
1936	Pasadena, Calif	*
1937	Spokane, Wash	266
1938	Portland, Ore	454

* Combined with summer convention.

Introduced by Chairman Merwin and received with an ovation was President Parker who spoke to the assembly on "Engineering Orientation." The entire text of the presidential address may be found elsewhere in this issue. Immediately following Doctor Parker's address, the first technical session was called to order, the opening presentation being an illustrated lecture given by A. W. Copley (A'04, F'26) of San Francisco who described the "atom smasher" research development of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa.

Technical Sessions

Attendance at the several sessions in Portland ranged from 275 to 45 and averaged more than 145 persons per session over the three-day period. Details of the technical program as previously published (*EE, July '38, p. 296*) were followed. Judging by the attention given, most of the papers were of absorbing interest although some were of a descriptive or reportorial character naturally not conducive to general discussion. Of the five papers presented at the communication session held jointly with the IRE, two were presented by the AIEE and three by the IRE.

President J. C. Parker speaking on "Engineering Orientation"

Presiding at the technical sessions were: F. O. McMillan of Corvallis, Ore., vice-president 1934–36; J. P. Jollyman of San Francisco, Calif., vice-president 1937–39; O. B. Coldwell of Portland, vice-president 1921–22; H. V. Carpenter of Pullman, Wash., vice-president 1930–32; C. B. Carpenter, chairman Portland Section 1938–39; L. R. Gamble of Spokane, Wash., vice-president 1937–39.

Exclusive of the student sessions, a total of 25 papers and one technical address were presented.

Student Technical Sessions

As usual, two student sessions were provided for as part of the convention program, accommodating 10 student papers:

Wednesday Afternoon—A. L. Tweeddale, Oregon State College, presiding.

Stabilized Negative Impedances, E. L. Ginzton, Stanford University.

A Thyratron Voltage Regulator for an Alternator, Ruper Sanborn, University of Idaho.

Ionization Time of Thyratrons, F. E. Llewllyn, California Institute of Technology.

Some Personalities From the 26th Pacific Coast Convention

Portland, Ore.

August 9–12, 1938

Upper row, left to right: L. T. Merwin (A'10, F'33) chairman of the opening session and member of the general committee, president and general manager of the Northwestern Electric Company, Portland; L. R. Elder (A'10, M'26) chairman of the reception committee, sales engineer for the Portland General Electric Company; C. B. Carpenter (A'23, M'34) chairman of the publicity committee and new chairman of the Portland Section, engineer for the Pacific Telephone and Telegraph Company, Portland; Dean H. V. Carpenter (A'03, F'18) past vice-president and member of the general committee, State College of Washington, Pullman; O. B. Coldwell (A'03, F'12) chairman finance committee, also first chairman of the Portland Section (1909) and past vice-president, vice-president of the Portland Electric Power Company

Lower row, left to right: John B. Fisken (A'03, F'13) first chairman of the Spokane Section and past manager and vice-president, consulting engineer, The Washington Water Power Company, Spokane; H. H. Schoolfield (M'18) past vice-president, chief engineer for the Pacific Power and Light Company, Portland; F. O. McMillan (A'14, F'32) past vice-president, head of the electrical-engineering department of Oregon State College, Corvallis; A. W. Copley (A'04, F'26) speaker on atom smashers, also promoter for 1939 summer convention in San Francisco and a past vice-president, Pacific Coast engineering manager for the Westinghouse Electric and Manufacturing Company, San Francisco; S. E. Caldwell (A'29) chairman registration committee and past chairman Portland Section, engineer for Pacific Power and Light Company, Portland

---

Vacuum-Tube Control of Saturated Reactors as Applied to Light-Intensity Control, W. T. Harrold, University of Washington.

An Investigation of Some of the Properties of a Nonlinear Circuit, Wallace Murdock and Ray Warburton, University of Utah.

Thursday Afternoon—J. C. Beckett, Stanford University, presiding.

Oscillographic Counting of Corona Discharge, W. E. Noller and Benjamin Davis, University of California.

Electrical Aids for Individual Cases of Deafness, Joseph Mascovich, University of Santa Clara.

Volume-Limiting Amplifier for Broadcast Use, L. M. Mallach, Washington State College.

Design of an Intermediate-Frequency Amplifier, J. A. Rhoades, University of Southern California.

A Quantitative Study of Copper-Oxide Modulators, D. W. Cox, Oregon State College.

CONFERENCE ON STUDENT ACTIVITIES

With Professor A. L. Taylor, retiring chairman of the committee on student activities for the Ninth District, presiding, a dinner and joint conference of Student Branch counselors and chairmen was held Tuesday evening, August 9, for the purpose of discussing problems pertaining to the operation of Student Branches in the Eighth and Ninth Districts and the western portion of the Tenth District. Of the 14 Student Branches in that territory 10 were represented by student chairmen or alternates, and 13 of the 14 student counselors were present:

Branch Chairmen or Alternates

Robert Ries, University of Idaho, Moscow.
H. R. Schneider, Montana State College, Bozeman.
A. L. Embry, University of Utah, Salt Lake City.
John Hamilton, University of Southern California, Los Angeles.
B. B. Goodridge, University of Arizona, Tucson.
E. L. Isaac, University of Nevada, Reno.
D. M. Sherwood, California Institute of Technology, Pasadena.
Joe Mascovich, Santa Clara University, Santa Clara, Calif.
W. A. Lawrence, University of California, Berkeley.
J. C. Beckett, Stanford University, Calif.

Counselors

R. H. Hull, University of Idaho, Moscow.
W. B. Coulthard, University of British Columbia, Vancouver.
J. C. Clark, University of Arizona, Tucson.
Abe Tilles, University of California, Berkeley.
C. F. Bowman, Montana State College, Bozeman.
S. G. Palmer, University of Nevada, Reno.
W. G. Angermann, University of Southern California, Los Angeles.
F. C. Lindvall, California Institute of Technology, Pasadena.
A. L. Taylor, University of Utah, Salt Lake City.
H. F. Lickey, Washington State College, Pullman.
R. E. Lindblom, University of Washington, Seattle.
A. L. Albert, Oregon State College, Corvallis.
H. H. Skilling, Stanford University, Calif.

The total attendance of 63 also included President John C. Parker, National Secretary H. H. Henline, Chairman R. W. Sorensen of the Institute's Committee on Student Branches, Vice-President L. R. Gamble, Vice-President J. P. Jollyman, Secretary A. M. Bohnert of District 8, and others interested in Student Branch activities.

This group considered various questions of interest and importance to Student Branches on the Pacific Coast, giving considerable attention to possible ways and means of assisting students to secure employment upon graduation. Called upon for closing comment, President Parker emphasized the necessity for engineering students to prepare themselves to go out and get jobs rather than to allow themselves to be drawn into the all too prevalent current habit of depending upon "thumbing" a free ride.

Tuesday noon, August 9, a group of 30-odd national, District, and Section officers, chairmen of local membership committees, and others gathered for a luncheon and subsequent informal discussion of local questions and an exchange of ideas and suggestions. Vice-President L. R. Gamble presided. Those present included President Parker, National Secretary Henline, Vice-President J. P Jollyman, several past vice-presidents, representatives from each of the Sections of the Pacific Coast territory, and others.

T. S. WOOD WINS FISKEN CUP

Entertainment, sporting events, and inspection trips were carried out in accordance with the published program (*EE, July '38, p. 295–6*). A generous schedule of activities was provided for both men and women. Chief among the sporting events was the annual golf tournament, for which there were 77 entrants. Winner of the John B. Fisken Cup, principal trophy, was T. S. Wood (M'20) of Seattle—82–18, 64 net. Honors for low gross score were won (again) by J. C. Henkle (M'36) past chairman (1926–27) of Portland Section—79; runner-up was M. P. Buswell (A'37) of Seattle. First choice in the blind bogey (kicker's handicap) was won by T. H. Crosby (M'37) of Vancouver, B. C. Inasmuch as the tournament—with the exception of the Fisken Cup—was open to guests as well as to members, several guests placed themselves within the prize range. A total of some 25 valuable prizes contributed to the committee were distributed, on the basis of top man successively being given first choice; a maximum of one prize was allowed for each individual.

COMMITTEES

Credit for the conduct of the Portland convention is due to the following committee workers, and to Retiring Vice-President C. E. Rogers of Seattle through whose efforts the general committee was organized and active at a very early date:

General Convention Committee—E. F. Pearson, general chairman; D. F. Smith, vice-chairman; Corbett McLean, secretary; John Bankus, treasurer; C. C. Boozier, C. Arnott, A. M. Bohnert, R. O. Brosemer, H. V. Carpenter, A. W. Copley, L. G. Fear, W. F. Grimes, M. F. Hatch, N. B. Hinson, C. H. Hoge, J. P. Jollyman, O. L. LeFever, F. M. Lewis, C. E. Magnusson, W. S. McCrea, F. O. McMillan, H. L. Melvin, L. T. Merwin, G. W. Miller, A. S. Moody, H. S. Osborne, S. G. Palmer, E. F. Peterson, A. C. Pratt, R. W. Preston, G. E. Quinan, C. E. Rogers, M. A. Sawyer, E. F. Scattergood, H. H. Schoolfield, H. H. Skilling,

G. H. Smith, R. W. Sorensen, A. L. Taylor, A. Vilstrup, F. D. Weber, and C. A. Wolfrom.

Finance—O. B. Coldwell, chairman; L. T. Merwin, L. G. Fear, E. D. Wise, John Bankus, A. S. Moody, and G. T. Bragg.

Meetings and Papers—Walter Brenton, chairman; F. O. McMillan and C. B. Carpenter.

Registration—S. E. Caldwell, chairman; C. E. Klaus, L. A. Helgesson, C. C. Boozier, H. I. Sargent, L. L. Smith, and D. L. Brown.

Hotel—R. J. Davidson, chairman; R. W. Preston, J. D. Frantz, L. H. Andrews, O. C. Doty, W. A. Leidigh, Jr., and O. W. Hurd.

Inspection Trips—V. B. Wilfley, chairman; R. B. Barnard, W. S. Boutwell, F. M. Lewis, J. A. Hooper, L. G. Walter, W. F. Robinson, and C. F. Stevey.

Publicity—C. B. Carpenter, chairman; Berkeley Snow, A. B. Cayo, John Dierdorff, F. S. Doxey, and O. A. Demuth.

Reception—L. R. Elder, chairman; Mrs. L. R. Elder, Mr. and Mrs. O. B. Coldwell, Dean and Mrs. R. H. Dearborn, Mr. and Mrs. D. F. Smith, Mr. and Mrs. H. H. Schoolfield, Mr. and Mrs. F. D. Weber, Mr. and Mrs. V. B. Wilfley, and Mr. and Mrs. E. F. Pearson.

Entertainment—A. H. Kreul, chairman; A. O. Mangold, G. L. Walker, J. F. Spease, and H. H. Cake.

Golf—J. C. Henkle, chairman; C. C. Boozier, J. E. Yates, and W. F. Hynes.

Women's Entertainment—Mrs. J. F. Spease, chairman; Mrs. J. H. Polhemus, Mrs. F. G. Barnett, Mrs. O. L. LeFever, Mrs. L. E. Kurtichanof, Mrs. D. R. McClung, Mrs. O. C. Doty, Mrs. H. H. Schoolfield, Mrs. L. A. Morphey, Mrs. F. V. Sams, Mrs. N. V. Arntzen, Mrs. G. F. Zolling, Mrs. W. F. Hynes, Mrs. C. E. Klaus, Mrs. C. C. Boozier, Mrs. A. B. Cayo, Mrs. H. H. Cake, Mrs. C. E. Canada, Mrs. C. P. Toussieng, and Mrs. W. C. MacInnes.

Student Activities—A. L. Albert, chairman; H. H. Skilling, and A. L. Taylor.

Transportation—G. E. Bishop, chairman; E. F. Anderson, O. C. Doty, Waldo Enns, and D. E. Roddy.

AIEE Directors Meet at Institute Headquarters

The regular meeting of the board of directors of the American Institute of Electrical Engineers was held at Institute headquarters, New York, N. Y., August 2, 1938.

Present: *President*—John C. Parker, New York, N. Y. *Past Presidents*—W. H. Harrison, New York, N. Y.; A. M. MacCutcheon, Cleveland, Ohio. *Vice-Presidents*—F. C. Bolton, College Station, Texas; C. L. Dawes, Cambridge, Mass.; F. M. Farmer, New York, N. Y.; L. R. Gamble, Spokane, Wash.; I. Melville Stein, Philadelphia, Pa. *Directors*—C. R. Beardsley, C. R. Jones, H. S. Osborne, New York, N. Y.; W. B. Kouwenhoven, Baltimore, Md.; L. R. Mapes, Chicago, Ill.; K. B. McEachron, Pittsfield, Mass.; D. C. Prince, Philadelphia, Pa.; R. W. Sorensen, Pasadena, Calif. *National Treasurer*—W. I. Slichter, New York, N. Y. *National Secretary*—H. H. Henline, New York, N. Y.

Minutes of the meeting of the board of directors held June 23, 1938, were approved.

Report was presented and approved of recommendations adopted by the board of examiners at a meeting held July 21, 1938. Upon recommendation of the board of examiners, the following actions were taken: 8 applicants were transferred to the grade of Fellow; 30 applicants were transferred and 19 were elected to the grade of Member; 120 applicants were elected to the grade of Associate; 15 Students were enrolled.

The finance committee reported disbursements in July amounting to $28,672.06, and the report was approved.

Amendments to the by-laws were adopted, as follows:

Section 8 revised to read as follows, to conform with the recent amendments to the constitution limiting admission to the grade of Fellow (*EE, July '38, p. 303–04*):

> Sec. 8. Transfer of an Associate to the higher grade of Member may be proposed by another member acting as sponsor, who, upon application to the national secretary, may obtain a short form upon which information may be submitted for preliminary consideration of the board of examiners, after which the sponsor will obtain the candidate's signature to the prescribed form of application, which will be acted upon in accordance with the usual procedure.

Section 43 amended, upon recommendation of the Sections committee, to read:

> Sec. 43. The chairman and secretary of each Section shall be elected for the term of one year, beginning upon the date specified in the by-laws of the Section. The by-laws of the Section shall determine whether or not these officers shall be eligible for re-election.

Announcement was made of the appointment by the president of Institute committees for the administrative year beginning August 1, 1938 (list published elsewhere in this issue).

As required by the by-laws of the Edison Medal committee, the board confirmed the following appointments by the president: L. W. W. Morrow as chairman for the year beginning August 1, 1938, and J. W. Barker, N. E. Funk, and W. H. Harrison as members of the committee for the five-year term beginning August 1, 1938. The board elected from its own membership to serve as members of the committee for the term of two years beginning August 1, C. L. Dawes, A. H. Lovell, and R. W. Sorensen.

In accordance with the by-laws of the Lamme Medal committee, the board confirmed the president's appointment of E. W. Allen, A. C. Flory, and W. B. Kouwenhoven as members of that committee for the three-year term beginning August 1, 1938.

The board considered a suggestion that the activities of the technical committees on general power applications, applications to iron and steel production, and applications to mining work, would be strengthened if the three committees were combined to form a single committee, with subcommittees covering the functions of the former committees. The board authorized the consolidation of the three committees into the "committee on industrial power applications," with the understanding that the chairman of the new committee will prepare a proposed definition of scope of the committee for submission to the technical program committee and the board of directors.

Representatives of the Institute on various organizations were appointed for the one-year term beginning August 1, 1938. J. F. Fairman was appointed a representative on the Engineers' Council for Professional Development for the three-year term beginning October 1938, and L. W. Chubb was nominated for reappointment by The Engineering Foundation Board as the Institute representative on the research procedure committee of the Foundation.

Future AIEE Meetings

Southern District Meeting
Miami, Fla., November 28–30, 1938

Winter Convention
New York, N.Y., January 23–27, 1939

South West District Meeting
Houston, Texas, Spring, 1939

North Eastern District Meeting
Springfield, Mass., May 1939

Summer and Pacific Coast Convention (combined)
San Francisco, Calif., June 26–30, 1939

Middle Eastern District Meeting
Scranton, Pa., October 11–13, 1939

Great Lakes District Meeting
Minneapolis, Minn., Fall, 1939

Local honorary secretaries were appointed for the two-year term beginning August 1, 1938, as follows: V. J. F. Brain for Australia, W. Elsdon-Dew for Transvaal, Africa, and A. S. Garfield for France.

Approval was given to recommendations of the standards committee for the appointment of the following Institute representatives:

P. B. Harwood and Gordon Thompson on the Sectional Committee on Industrial Control Apparatus (to replace H. D. James and E. D. Doyle, resigned).

Professor E. D. Ayres on the Sectional Committee on Wood Poles (to replace C. D. Gray, resigned).

I. Melville Stein as an additional representative on the Sectional Committee on Electric and Magnetic Magnitudes and Units.

Professor D. F. Minor on the Sectional Committee on Wire and Sheet Metal Gauges (to replace S. H. Blake).

C. T. Sinclair on ASTM Committee *B*-1—Copper and Copper Alloy Wires for Electrical Conductors (to replace C. D. Gray, resigned).

Other matters were discussed, reference to which may be found in this or future issues of Electrical Engineering.

Coffin Award to Cincinnati Gas and Electric. The Cincinnati Gas and Electric Company recently was awarded the Charles A. Coffin Medal for 1937, for its outstanding contributions to the public. The company's extraordinary efforts in maintaining uninterrupted service successfully during the Ohio River flood, and in promoting the use of electricity by effecting one of the lowest domestic rate schedules in the United States were cited at the presentation during the annual meeting of the Edison Electric Institute, Atlantic City, N. J., June 8, 1938. Accompanying the gold medal was a check for $1,000 to be given to the employees' welfare fund of the company. The Charles A. Coffin Foundation, established by the General Electric Company in 1922 in honor of its founder and first president, each year presents a gold medal and $1,000 to the company which during that year has made a distinguished contribution to the development of electric light and power for convenience of the public and benefit of the industry.

Plans Progressing for Southern District Meeting

As already announced in Electrical Engineering, arrangements are being made for the AIEE Southern District meeting, which will be held in Miami, Fla., November 28–30, 1938. Headquarters will be in the Miami Biltmore Hotel at Coral Gables. Excellent facilities are available for sports—golf, tennis, swimming, and fishing—and the location of the meeting will afford attendants a few days of winter vacation.

The program will include three technical sessions and an afternoon student session. Groups of papers for the technical sessions will deal with the subjects of radio and telephony, electric power generation, and transmission and distribution. There will be other papers and discussion dealing with economic and social problems from an engineering viewpoint.

Entertainment features will consist of a smoker Monday evening and a formal dinner-dance Tuesday night. Sightseeing trips to points of interest in the Miami area will be arranged. Consideration is being given to a four-day post-convention trip to Havana via Overseas Highway to Key West, boat to Havana, and return to Miami by boat. Miami to Havana by plane will be optional at a slight increase in cost. Further information on the Havana trip will be available later after more definite plans have been developed.

Sky Line of Miami, Fla., scene of Southern District meeting

Additional Prize Awards Announced by District 8

In addition to the prize awards for technical papers already announced by the AIEE Districts (*EE July '38, p. 316*) the Institute's Pacific District (number 8) has announced the following awards for student papers for the year ending June 30, 1938:

Prize for Branch paper was awarded to Walter E. Noller and Benjamin Davis for their paper "Oscillographic Counting of Corona Discharges," presented at a joint meeting of the San Francisco Section and the University of California, Stanford University, and University of Santa Clara Branches, April 22, 1938.

Prize for graduate student paper was awarded to Robert R. Buss for his paper "The Application of Feedback to Selective and Equalizer Circuits," presented at a meeting of the Stanford University Branch, May 24, 1938.

Three Committees on Applications Combined

As announced in the report of the AIEE board of directors' meeting published elsewhere in this issue, the board has authorized the consolidation of the committees on general power applications, applications to iron and steel production, and applications to mining work into one committee to be known as the AIEE committee on industrial power applications.

It has been thought for some time that the work of these applications committees should be integrated and strengthened, and this consolidation was authorized for that purpose. Although the scope of the consolidated committee has not yet been defined, preliminary plans are to widen it to include not only the scopes of the three former committees, but other activities as well. It is planned also to have subcommittees to represent the various classes of industries in which electricity is applied extensively.

The committee on general power applications was organized in 1908; on applications to mining work, in 1912; and on applications to iron and steel production, in 1914. All three committees have functioned continuously since they were established.

J. D. Wright (A'36) assistant manager, industrial department, General Electric Company, Schenectady, N. Y., has been appointed chairman of the consolidated committee; the names of other members will be announced later.

Institute Funds for Research Projects

In the past the AIEE has sponsored various research projects by recommending to The Engineering Foundation that in the judgment of the Institute a given project was worthy of support. The Institute, however, did not provide any financial support.

This Institute activity was thoroughly discussed at the meeting of the board of directors held in October 1937, and the board approved in principle the idea of contributions by the Institute toward specific research projects that it recommends to The Engineering Foundation, but decided to limit such contributions to not more than $500 for any one project in a year and to a total sum for all such projects during a budget year not exceeding one-half of one per cent of the total gross income of the AIEE for the preceding fiscal year.

In view of this action of the board, the chairman of the committee on research, W. B. Kouwenhoven, appointed a special subcommittee consisting of W. F. Davidson, *chairman*, O. E. Buckley, and Thomas Spooner to review any research project for which sponsorship and funds are requested and to report its findings and recommendations to the committee on research and to any other technical committee interested in the given project. These committees act upon such reports and present their recommendations to the board of directors of the Institute.

To date, two projects have been referred to the special subcommittee for action: "Stability of Impregnated Paper Insulation," and "Welding Research." In both instances the special subcommittee recommended that the Institute act as sponsor for the projects and that it support them by nominal grants made from Institute funds.

New NEMA Standards Published. New standards entitled "NEMA Motor and Generator Standards," publication 38-49, recently was issued by the National Electrical Manufacturers Association to supersede the previous edition (publication 34-22) which was issued in 1934. Some of the new material published in these standards includes temperature ratings of enclosed motors, standardized lettering for flange-mounted motors, methods of measuring motor vibration, and much of the material contained in the previous standards has been revised and augmented. Copies of the new standards may be obtained from the National Electrical Manufacturers Association, 155 East 44th Street, New York, N. Y., at two dollars per copy.

Graduate Evening Courses at Stevens. For the first time, Stevens Institute of Technology, Hoboken, N. J., will offer during the academic year 1938–39 a program of evening graduate courses in engineering. Co-ordinated groups of related courses are being offered in the fields of mechanical engineering, electrical engineering (specializing in communication) and economics of engineering. With the exception of a few noncredit courses, each course will carry credit in one or more approved programs leading to the degree of master of science.

Lamme Medal Nominations Due December 1

Attention is called again to the opportunity open to any member of the Institute to submit nominations for the 1938 AIEE Lamme Medal. All nominations must be received not later than December 1 (for further particulars, see ELECTRICAL ENGINEERING for June 1938, page 266). The 1937 Lamme Medal was presented to Doctor R. E. Doherty, president, Carnegie Institute of Technology, Pittsburgh, Pa., at the recent AIEE summer convention in Washington, D. C.

CIGRE Offers Full Proceedings of Conclave

Three bound volumes comprising a total of approximately 3,000 pages and including some 863 illustrations covering the 1937 meeting of the Conference Internationale Des Grands Reseaux Electriques are now available, according to an announcement recently received. The announced price is 450 francs (375 francs for permanent members of the CIGRE); interested persons should communicate with the CIGRE, 54, Avenue Marceau, Paris, France.

The Proceedings are published in French and contain the full text of the 119 papers presented, as well as a transcription of the shorthand record of all the discussions. The contents of the three volumes are as follows:

Volume I: Generation, Transformation, and Circuit Breaking. Alternators; parallel running; metering, metering and control instruments; transformers; insulating oils; insulating materials other than oils; switches and circuit breakers.

Volume II: Construction, Insulation, and Maintenance of Overhead and Underground Networks. Cables; overhead conductors; frost and snow, wind; poles and pylone; insulators.

Volume III: Operation, Protection, and Interconnection of Networks. Telephone and radio interference; earthing; organization and operation of networks; lightning and lightning arresters; surges; signaling, remote control and indication; overloads; discriminative protection; safety.

ASTM Awards Dudley Medal. For his paper "Analysis of the Brinell Hardness Test" the American Society for Testing Materials has awarded the Charles B. Dudley Medal for 1938 to Robert H. Heyer, junior metallurgist, research laboratories, The American Rolling Mill Company. This medal, which commemorates the name of the first president of ASTM, is awarded to the author or authors of the paper presented at the preceding annual meeting that is of outstanding merit and constitutes an original contribution on research and engineering material.

Coffin Fellowships. Nine college graduates have been granted Charles A. Coffin fellowships, totaling $5,000, for use in carrying on advanced scientific research during the coming school year, according to a recent announcement. The fellowships were established by the General Electric Company in 1922 to honor its retiring president and founder, and are awarded each year to graduates of colleges in the United States who have shown by the character of their work that they could with advantage undertake or continue research work in educational institutions either in this country or abroad. Among the winners are R. P. Krebs (Enrolled Student) Cincinnati, Ohio, and E. M. Williams (Enrolled Student) Wallingford, Conn. President John C. Parker is AIEE representative on the Charles A. Coffin fellowship and research committee.

"Musa" to Be Used in New Transatlantic Phone Station

A tract of land on the Manahawken Great Meadows in New Jersey over 2,500 acres in extent has been acquired by the American Telephone and Telegraph Company to be used as a receiving station site for the company's transatlantic telephone service, according to an announcement in a recent issue of the *Bell Laboratories Record*. The selection of the tract at Manahawken was dictated by the use of the multiple-unit steerable antenna system which was developed by Laboratories engineers. There will be a series of 16 antenna units in a line about two miles long. This system, known as the "musa," greatly reduces the effect of fading and is highly efficient in separating the desired signal from interfering noises such as static and other electrical disturbances.

The line of antennas will be aimed at the Rugby transmitting station near London, England. The antenna wires will be strung in the form of 16 diamonds, on poles some 65 feet above the ground, each unit antenna being about 450 feet long. Adjacent to the antennas will be a brick building housing the receivers and auxiliary apparatus. The antennas will be connected to the receivers by coaxial cables. The station is expected to be ready for operation by the spring or summer of 1939.

Bennett M. Brigman Memorial. Friends and former students of Bennett Mattingly Brigman, late dean of the Speed Scientific School of the University of Louisville (Ky.), are attempting to create a memorial in his honor. The proposed plan, according to an announcement made by the Bennett M. Brigman Memorial Committee, is to create a permanent and perpetual student loan fund to assist worthy students in attending that school. Dean Brigman received a part of his formal education at the University of Louisville (*EE, Mar. '38, p. 142*) and was appointed to the faculty of the university in 1912. In 1923 he organized the Speed Scientific School of that Institution and was made its dean, a position he held continuously until his death on February 8, 1938.

Proceedings of the Rubber Technology Conference, held in London, England, May 23–25, 1938 has been announced as soon to be available. This volume, said to "represent the forefront of advanced thought in the science and general technology of rubber," is scheduled to contain on its 1,000-odd 9- by 12-inch pages the 103 scientific and technical papers read at the conference, and the important discussions thereon. These papers were prepared by authors representing 16 different countries, and are said to cover "almost every conceivable phase of rubber technology, from the physiology of latex-yielding plants to the marketing of manufactured rubber articles." Several papers deal with the subject of electric power cables. The quoted price is £ 2 2s. Persons interested should correspond directly with the Institution of the Rubber Industry, 12 Whitehall, London, S.W.1, England.

Future Meetings of Other Societies

American Association for the Advancement of Science. Winter meeting, December 27–31, Richmond, Va.

American Chemical Society. Fall meeting, September 5–9, Milwaukee, Wis.

American Gas Association. October 10–14, Atlantic City, N. J.

American Institute of Mining and Metallurgical Engineers. Petroleum division, October 6–7, Los Angeles, Calif.

Industrial minerals division, October 20–21, Los Angeles, Calif.

Coal division (joint meeting with ASME and Western Society of Engineers) October 13–15, Chicago, Ill.

American Physical Society. 223d meeting, November 25–26, Chicago, Ill.

224th meeting, December 1938, Los Angeles, Calif.

Annual meeting, December 26–28, Washington, D. C.

American Society of Mechanical Engineers. Wood industries division, September 22–23, High Point, N. C.

Applied mechanics division, September 28–30, Los Angeles, Calif.

Fall meeting, October 5–7, Providence, R. I.

Fuels division, October 13–15, Chicago, Ill.

American Transit Association. 57th annual convention, September 19–22, Atlantic City, N. J.

Association of Iron and Steel Engineers. Annual convention and iron and steel exposition, September 27–30, Cleveland, Ohio.

International Congress of Applied Mechanics. September 12–16, Cambridge, Mass.

International Management Congress. September 19–23, Washington, D. C.

National Electrical Contractors Association. September 12–15, Detroit, Mich.

National Electrical Manufacturers Association. October 24–28, Chicago, Ill.

National Research Council, Highway Research Board. 18th annual meeting, November 20–December 2, Washington, D. C.

National Metal Congress. October 17–20, Detroit, Mich.

National Safety Congress. Silver jubilee, October 10–14, Chicago, Ill.

Society of Automotive Engineers. National regional fuels and lubricants meeting, October 6–7, Tulsa, Okla.

National aircraft production meeting, October 13–15, Los Angeles, Calif.

Letters to the Editor

CONTRIBUTIONS to these columns are invited from Institute members and subscribers. They should be concise and may deal with technical papers, articles published in previous issues, or other subjects of some general interest and professional importance. ELECTRICAL ENGINEERING will endeavor to publish as many letters as possible, but of necessity reserves the right to publish them in whole or in part, or reject them entirely.

ALL letters submitted for consideration should be the original typewritten copy, double spaced. Any illustrations submitted should be in duplicate, one copy to be an inked drawing but without lettering, and other to be lettered. Captions should be furnished for all illustrations.

STATEMENTS in these letters are expressly understood to be made by the writers; publication here in no wise constitutes endorsement or recognition by the American Institute of Electrical Engineers.

Journals for Electrical Engineers

To the Editor:

In the March issue of ELECTRICAL ENGINEERING (pages 110–13) C. F. Dalziel presents an analysis to facilitate, for an individual or an institution, the selection of the necessary journals dealing with electrical engineering. This analysis is based on the number of references given to these journals in other technical periodicals. The writer takes the liberty to make two objections: against the scope, and against the method of analysis. He wishes to emphasize that his deductions should not be understood as a mere criticism, but as an attempt to clarify the problem and to show a way for another solution.

As to the scope, there seem to be two different problems:

1. To select the most important magazines dealing with electrical engineering in general, if certain limited funds are available. Such a situation might exist in the case of a college or public library.

2. To select the most important magazines for an organization or an individual which works on a special field in the art.

Obviously, the selection as suggested by Mr. Dalziel applies only to the first group. Therefore, the following remarks are confined to this group also.

The method of analysis seems to be questionable in considering the results. The tables indicate that the most important magazines for electrical engineers are those dealing with pure or applied physics. This is certainly incorrect. The result is caused by the fact that the physicist—in general at least—is used to work more scientifically, more systematically, than the engineer. He takes the time to investigate the work previously done on his subject, and he refers to it. Why not admit that this method is not only more scientific, but also more economical because it avoids doing things again which already have been done and published?

Be this as it is, it seems hardly possible to use a method for grading which depends on such complex quantities as educational standard of the reader and his knowledge of foreign languages. Take for instance magazines 10 and 11 of table I, *Elektrische Nachrichten-Technik* (*ENT*) and *Elektrotechnische Zeitschrift* (*ETZ*), both published in the same language. With its 12 issues per year, *ENT* is referred to in foreign magazines 173 times; and the voluminous *ETZ*, with 52 issues per year, only 165 times. Is the *ENT*, then, a more important journal for a public library? Certainly not; but its highly mathematical papers will be studied from, and quoted by, the scientifically trained communication specialists of the whole world, whereas the *ETZ* can be found on the desk of nearly every German electrical engineer. It is pretty much the same relation as exists in the United States between the *Bell System Technical Journal* (with 4 issues per year and 80 references) and *Electrical World* (with 24 technical and 24 news issues, and 109 references).

What is the best way to get rid of such intangible quantities as educational standard? The writer wants to suggest this: to analyze the last two volumes of the *Science Abstracts*, section *B*, electrical engineering. It is merely necessary to count how frequently the various magazines are abstracted. Two consecutive volumes are suggested in order to have the proper count of those important papers presented before the Conférence Internationale des Grand Réseaux Electriques à Haute Tension which meets every two years. As a check, a similar abstracting magazine might be analyzed, for instance, the new German home product *Electrotechnische Berichte*.

Of course, such abstracting magazines deal chiefly with the main technical articles published in the journals under review; but it is this aspect which is in accordance with the interests of a public library. A manufacturing or operating concern, or an individual, might be interested in quite different parts of a journal, as: contracts and tenders, or positions offered and wanted; but a classification or grading from this point of view is certainly beyond the scope of the problem under consideration.

Yours very truly,
LUDWIG F. ROEHMANN (M'37)

(Electrical Engineer, Anaconda Wire & Cable Company, Hastings-on-Hudson, N. Y.)

The Role of the Engineering Library

To the Editor:

The timely article on "The Role of the Engineering Library," by Harrison W. Craver, published in the July issue of ELECTRICAL ENGINEERING (pages 291–4) is interesting and challenging to both educators and engineers in industry.

As the author indicates, the number of books now available is so enormous that careful selection is necessary by most libraries on account of budgetary limitations. Much assistance is being rendered the smaller college libraries by a pamphlet entitled "Selected Bibliography of Engineering Subjects, Section IV, Electrical Engineering and Mechanical Engineering," and published under the auspices of the Engineers Council for Professional Development. A good illustration of a much smaller selection is Lucke's Condensed Library of Engineering.

Particularly in view of the very large number of engineering periodicals now being published, a carefully chosen list of electrical periodicals should be prepared to supplement the selected book bibliographies now existing.

Even though "the library needs of the engineers have received scant attention until recent times," in the words of Doctor Craver definite attempts are now being made by engineering colleges to teach students methods of library usage, and to inculcate in them the "library habit." It was the good fortune of the electrical-engineering division of the Society for the Promotion of Engineering Education, under my chairmanship, to have Mrs. Ruth McG. Lane, Vail Librarian of the Massachusetts Institute of Technology, discuss, at the Cambridge convention in 1937, "The Place of the Technical Library in Engineering Education." This excellent paper is published in the April 1938 issue of the *Journal of Engineering Education.*

Very truly yours,
A. NAETER (A'23, M'30)

(Professor and Head, Department of Electrical Engineering, Oklahoma Agricultural & Mechanical College, Stillwater, Okla.)

Ambient Temperatures for Overloading Transformers

To the Editor:

Because of the increasing demand for full utilization of investment by public utilities, the overloading of transformers on a temperature basis is daily becoming a more fundamental problem in engineering. Several methods have been presented in engineering literature by which overloads may be calculated for specified conditions of winding temperature, load cycle, and ambient temperature. The limiting winding temperature can be determined quite definitely from the known relation between temperature and life of insulation, and the load cycle predicted from previous load readings. The major difficulty lies in the determination of an ambient temperature on which to base the calculations of overload capacity.

During the past year I have done considerable work on this problem and have devised a method based upon the temperature-life equation for insulation in oil by which ambient temperatures for calculating overloads can be determined.

The major limiting feature on the load that a transformer can carry is the temperature that the windings attain under such load, and the length of time that the temperature endures. Since temperature rise over ambient temperature varies as a function of the load, the load that a transformer can safely carry without exceeding a definite limiting total temperature is dependent upon the ambient temperature, the load increasing as the ambient decreases and vice versa. However, it is practically impossible to vary the load day by day to allow for daily variation in ambient temperatures and still maintain the same load-cycle configuration. For this reason it has been decided to use an equivalent ambient temperature on which to base ratings for various months or periods of the year, which should have the same effect on the life of the transformer as would the actual ambient temperatures that occur during the period in question.

Listed in table I are the equivalent ambient temperatures that have been recommended for use in the vicinity of Philadelphia, Pa. Two values are given for each month or period of the year, one a true and the other an effective ambient temperature to include the effect of the sun in heating a transformer. When peak loads occur between sunrise and sunset, it has been recommended that the effective ambient-under-sun temperature be used. Generally ambient temperatures of 10 degrees centigrade for the winter period (November through March) and 30 degrees centigrade for the summer period (April through October) have been recommended because the yearly load cycle can be divided into these two periods, and because summer peaks usually occur during the day and winter peaks at or shortly after sunset.

According to V. M. Montsinger,[1,2] the life of a transformer out to a time of 20 years can be expressed as a function of the hot-spot temperature at which the transformer operates during that time:

$$Y = 7.15 \times 10^4 \epsilon^{(-0.088X)} \qquad (1)$$

where

Y = life in years

X = hot-spot temperature in degrees centigrade

ϵ = base of Naperian logarithms

If the hot-spot temperature (X) is split into two components, the hot-spot rise above ambient (θ), and the ambient temperature (A), this equation may be written

$$Y = \frac{7.15 \times 10^4 \epsilon^{(-0.088\theta)}}{B} \qquad (2)$$

where

$$B = \epsilon^{(0.088A)} \qquad (3)$$

The distribution of daily maximum temperatures for each month of the year was obtained from data taken at the United States Weather Bureau covering the past 47 years. These data were tabulated as shown in columns I and II in the appendix, by recording the number of times that the daily maximum temperature occurred between specified limits chosen at fixed intervals. By evaluating B for the mean of each interval and weighting by the number of occurrences in that interval, an average value of B was determined, and from it a value for the equivalent ambient temperature A. This ambient temperature (A) in combination with any fixed value of hot-spot rise (θ) will give the same life for the transformer from equation 2 as that transformer would have for the same hot-spot rise (θ) in combination with all the ambient temperatures that can occur during that month, each weighted according to the probable frequency of its occurrence. In the appendix is given an example for the temperature distribution of the month of December and the method of calculating the ambient temperature (A) to be used. Ambient temperatures for entire winter and summer periods have been derived in the same fashion as for the individual months.

According to Mr. Montsinger, transformers when operating under the sun during June and July will be from six to eight degrees hotter than if they were in the shade. According to our somewhat approximate calculations taking into account the absorptivity of transformer paint, the average exposed area of a transformer in proportion to its rated losses, and the intensity of solar radiation at the surface of the earth, a figure of seven degrees centigrade seems to be a fairly conservative one for the increase in transformer temperatures due to the sun. By taking into account the percentage of sunshine during the various months in combination with the annual curve of solar intensity at 40 degrees north latitude at the earth's surface, temperatures to be added to the ambient temperatures for each month in order to allow for heating by the sun have been derived in the same way as were the ambient temperatures.

Because the recommended ambient temperatures have been based upon daily maximum temperatures which usually last but two or three hours a day and, therefore, are not usually effective due to the large thermal capacity of transformers, it is believed that these temperatures should form a fairly conservative basis for rating outdoor transformers. A further safety factor in utilizing these ambient temperatures for winter and summer periods is that loads in general are never constant throughout the periods; and with peak ratings based upon these figures, some life will be gained at those times when the load is not up to its peak value.

The results of this analysis have shown that the equivalent ambient temperatures for months or periods of the year will not be exceeded during 60 per cent of the time, thus bringing out the weighted effect of the exponential life equation at higher temperatures; if life were directly proportioned to temperature, it would be possible to use average values throughout. The maximum deviations above the equivalent ambient temperatures are 25 degrees centigrade for the winter period and 17 degrees centigrade for the summer period; and the probability that the actual ambient temperature will be more than 10 degrees centigrade above the equivalent ambient is ten per cent for the winter period and five per cent for the summer period.

Table I. Equivalent Ambient Temperatures for Use in Philadelphia, Pa.

Month	True Ambient Temperature (Degrees Centigrade)	Effective Ambient-Under-Sun Temperature (Degrees Centigrade)
January	6	7
February	6	8
March	12	15
April	18	22
May	24	28
June	28	33
July	30	35
August	29	33
September	26	29
October	20	22
November	13	14
December	8	9
Winter Period November through March	10	11
Summer Period April through October	26	30

Table II. Calculation of Ambient Temperature (A) for Month of December

(I) Daily Maximum Temperature Limits (Deg. F)	(II) No. of Times Daily Maximum Temperature Between Limits of (I)	(III) Average Value of A_F for Limits of (I) (Deg. F)	(IV) Value of $\epsilon^{(0.0489 A_F)}$ for A_F of (III)	(V) Product of (II) by (IV)
9.5–12.5	2	11	1.63	3
12.5–15.5	2	14	1.98	4
15.5–18.5	5	17	2.30	12
18.5–21.5	7	20	2.66	19
21.5–24.5	15	23	3.09	46
24.5–27.5	52	26	3.57	186
27.5–30.5	49	29	4.14	203
30.5–33.5	95	32	4.79	454
33.5–36.5	127	35	5.55	705
36.5–39.5	167	38	6.42	1,072
39.5–42.5	191	41	7.47	1,428
42.5–45.5	166	44	8.60	1,428
45.5–48.5	148	47	9.97	1,476
48.5–51.5	116	50	11.54	1,340
51.5–54.5	91	53	13.40	1,220
54.5–57.5	73	56	15.50	1,132
57.5–60.5	63	59	17.90	1,129
60.5–63.5	34	62	20.80	708
63.5–66.5	18	65	24.10	434
66.5–69.5	5	68	27.90	140
Total	1,426			13,139

APPENDIX

Because ambient temperatures are measured in degrees Fahrenheit at the Weather Bureau, equation 3 can be rewritten

$$B = \epsilon^{(0.0489 A_F - 1.565)} \qquad (4)$$

or

$$B = 0.209\, \epsilon^{(0.0489 A_F)} \qquad (5)$$

where

A_F = ambient temperature in degrees Fahrenheit

Table II shows the method used in calculating the average value of B and determining from it the value of A to be used for the month of December.

$$\text{Average } \epsilon^{(0.0489 A_F)} = \frac{13{,}139}{1{,}426} = 9.23$$

From equation 5,

$$B = 0.209 \times 9.23 = 1.930$$

From equation 3, solving for A

$$A = \frac{\log_\epsilon 1.930}{0.088} = 7.5 \text{ degrees centigrade}$$

REFERENCES

LOADING TRANSFORMERS BY TEMPERATURE, V. M. Montsinger, AIEE TRANSACTIONS, volume 49, 1930, pages 776–90.

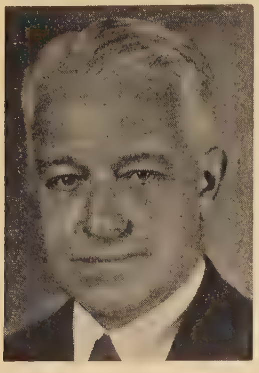
TEMPERATURE LIMITS FOR REACTORS AND TRANSFORMERS, V. M. Montsinger, AIEE TRANSACTIONS, volume 57 (January section) 1938, pages 39–44.

Very truly yours,
RAYMOND J. WOODROW (A'38)

(Junior Engineer, Philadelphia Electric Company, Philadelphia, Pa.)

Personal Items

H. W. Leitch (A'98, M'13) recently was elected vice-president in charge of electrical operations of the Consolidated Edison Company of New York, Inc., New York, N. Y. Mr. Leitch was born in Brooklyn, N. Y., October 31, 1875, was graduated from the Polytechnic Institute of Brooklyn with the degrees of bachelor of science (1894) and electrical engineer (1895), and obtained employment with The New York Edison Company as a dynamo tender in 1895. Later he became successively system operator, chief operator, and assistant superintendent of generating stations, before being transferred to the United Electric Light and Power Company as superintendent of the plant in 1913. In 1923 Mr. Leitch was made general superintendent of power plants, and in 1932 became associate chief operating engineer of both the United Electric Light and Power Company and The New York Edison Company. Shortly after the merger of The New York Edison Company into the Consolidated Edison Company of New York, Mr. Leitch was made engineer of operation.



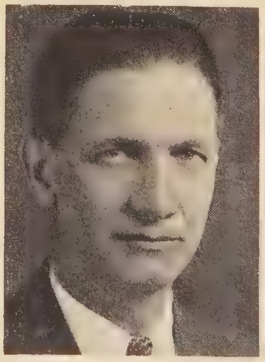
H. W. LEITCH

I. H. Sclater (A'08, F'27) has been appointed managing engineer of the power transformer department, General Electric Company, Pittsfield, Mass. A native (1883) of Palmyra, Va., and an electrical engineering graduate of Virginia Polytechnic Institute, Mr. Sclater has been associated with the General Electric Company continuously since 1906, when he entered the company as a test engineer. He was placed in charge of the design of oil-insulated transformers in 1923, and in 1931 became assistant engineer of the transformer-engineering department. He became engineer of that department in 1933.

Philip Torchio (A'95, F'12) vice-president of the Consolidated Edison Company of New York, Inc., New York, N. Y., retired recently. A native of Italy, Mr. Torchio was graduated from the University of Pavia with the degree of bachelor of arts (1890), and from the Royal Polytechnic of Milan with the degrees of mechanical engineer and electrical engineer (1893). He came to the United States in 1893 and was employed by the Sprague Electric Elevator Company as a draftsman. Two years later he was employed as a draftsman by the Edison Electric Illuminating Company of New York, predecessor of The New York Edison Company. In 1899 Mr. Torchio was made statistician, then successively engineer of economics, engineer of distribution, chief electrical engineer; and, in 1924, vice-president in charge of electrical engineering. At that time he acted also as consulting engineer for several affiliated utility companies. Before the merger of The New York Edison Company and the United Electric Light and Power Company, he was senior vice-president and a director of both companies.

E. W. Gorry (A'18) superintendent of the a-c substation operations bureau, Consolidated Edison Company of New York, Inc., New York, N. Y., retired recently after more than 48 years of service. Mr. Gorry was born in New York, September 8, 1873, and obtained his first position with the Westinghouse Electric and Manufacturing Company in 1889. In the following year he was employed by the United Electric Light and Power Company, a predecessor of the Consolidated Edison Company, as an armature winder. Later he became successively assistant foreman of the repair shops, operator, chief operator operating superintendent, superintendent of the operating department, and superintendent of a-c substations.

L. L. Crump (M'32) has been elected vice-president of the James R. Kearney Corporation, St. Louis, Mo. Born in Centralia, Mo., in 1891, Mr. Crump was graduated from Missouri State University with the degree of bachelor of science in electrical engineering in 1914, following which he became an apprentice for the Emerson Electric Manufacturing Company. In 1915 he became a construction engineer for the Union Electric Light and Power Company, St. Louis, remaining with that company in various capacities until 1930. In that year he became a design engineer for the W N. Matthews Corporation, St. Louis. Two years later he became affiliated with the James R. Kearney Corporation, his first position being as design and sales engineer. For the last five years Mr. Crump has been assistant chief engineer of the company.



L. L. CRUMP

H. C. Sheldon (A'36) has established his own electrical manufacturing organization under the name of Sheldon Service Corporation, Long Island City, N. Y. Mr. Sheldon was born in Boston, Mass., in 1903 and attended Amherst College before becoming affiliated with the Scoville Manufacturing Company, Waterbury, Conn. During the last eight years Mr. Sheldon has been associated with the Burndy Engineering Company, New York, N. Y., his most recent position being district manager.

L. A. Grettum (A'24) has been elected president of the Northwest Electric Light and Power Association. Following his graduation from the University of Minnesota in 1923, Mr. Grettum was employed in the engineering department of the Mississippi Valley Public Service Company. Since 1933 he has been operating manager of the Eastern Oregon Light and Power Company, Baker, Ore.

Edward Beck (M'35) has been transferred to East Pittsburgh, Pa., as lightning arrester engineer in the switchgear engineering department of the Westinghouse Electric and Manufacturing Company. Formerly Mr. Beck served as a member of the Westinghouse industry engineering department, and as chief engineer of the Westinghouse X-Ray Company, Inc., Long Island City, N. Y.

K. B. McEachron (A'14, F'37) has received the degree of doctor of engineering from Ohio Northern University. Doctor McEachron was graduated from Ohio Northern in 1913. He is director of high-voltage research at the Pittsfield (Mass.) works of the General Electric Company.

E. A. Coomes (A'36) has received an appointment as instructor in physics at the University of Notre Dame, Notre Dame, Ind., where he will direct research in electronics. He recently received the degree of bachelor of science at Massachusetts Institute of Technology.

J. A. M. Lyon (A'38) recently was appointed instructor in electrical engineering at The Johns Hopkins University, Baltimore, Md. Previously Doctor Lyon was engaged in transmission and relay work in the electrical engineering department of the Utility Management Corporation, Reading, Pa.

O. E. Buckley (M'19, F'29) has been made a member at large of The Engineering Foundation Board by the Board of Trustees of the United Engineering Trustees, Inc. Doctor Buckley is executive vice-president of the Bell Telephone Laboratories, Inc., New York, N. Y.

A. W. Robertson (A'27) has been appointed to the board of directors of the National Association of Manufacturers. Mr. Robertson is chairman of the board of directors of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

H. H. Porter (A'96, M'12) recently was awarded the honorary degree of doctor of engineering by Rensselaer Polytechnic Institute. Doctor Porter is chairman of the board of the American Water Works and Electric Company, New York, N. Y.

H. C. Silent (A'21, M'29) has become an engineer for the Southern California Telephone Company, Los Angeles, Calif. Mr. Silent previously was engineering superintendent of Electrical Research Products, Inc., Hollywood, Calif.

C. D. Poey (A'22, M'37) has become district sales manager of the Art Metal Company, New York, N. Y. Formerly Mr. Poey was chief engineer of the lamp division of the Greist Manufacturing Company, New Haven, Conn.

A. J. Hornfeck (A'37) recently joined the research department of the Bailey Meter Company, Cleveland, Ohio. Previously Mr. Hornfeck was employed in the engineering general department of the General Electric Company, Schenectady, N. Y.

C. F. Schwan (A'37) has become assistant to the chief engineer of the Peerless Electric Company, Warren, Ohio. Mr. Schwan has been a design engineer for the Apex Electrical Manufacturing Company, Cleveland, Ohio.

G. F. Tinkler (A'36) has become assistant personnel examiner for the State of California, with offices at Sacramento. Formerly Mr. Tinkler was general engineer for the Acme Breweries, San Francisco.

K. N. Wilkens (A'37) has become a timekeeper for the L. E. Myers Company, Chicago, Ill. Mr. Wilkens has been an electrician for the Mueller Brass Company, Port Huron, Mich.

J. H. Wyman (A'37) has become factory engineer for the National Union Radio Corporation, Newark, N. J. Mr. Wyman has been production engineer for the Triad Manufacturing Company, Pawtucket, R. I.

I. E. Siewert (A'35) has been transferred to Zanesville as building supervisor for the Ohio Bell Telephone Company. Previously Mr. Siewert was building foreman for the same company at Toledo.

A. E. Hecker (M'30) superintendent of the Poplar Bluff (Mo.) Municipal Light and Water Plant for the last 22 years, has resigned his position.

D. M. Morley (A'38) has become a student engineer for the General Electric Company, Lynn, Mass.

Obituary

Frank William Roller (A'95, M'01, F'12) president of the Roller-Smith Company, New York, N. Y., died August 21, 1938. Colonel Roller was born May 29, 1874, at New York, and was graduated from Lehigh University in 1894 with the degree of mechanical engineer. Shortly after graduation he became associated with J. A. Machado, an electrical contractor in New York. In 1898 he was commissioned assistant engineer, United States Navy, serving on the U.S.S. "Nashville" as assistant engineer and finally as chief engineer during the Spanish-American war. Following honorable discharge, he renewed his association with Mr. Machado in the firm of Machado and Roller, importers of electrical instruments and agents for the Whitney Electrical Instrument Company, Switchboard Equipment Company, and Columbia Meter Company. These companies were taken over by the Roller-Smith Company, which was organized in 1908 with Colonel Roller as president. During the World War he served in the ordnance department, United States Army, in a civilian capacity. At the time of his death he was chairman of the board of the Sarco Company, and commissioned in the Ordnance Reserve Corps. He was a member of the Institute's board of examiners 1903–05, and of the library committee 1905–06.

John Chester Warner (M'34) vice-president of the RCA Manufacturing Company, Inc., Harrison, N. J., was killed in an automobile accident July 21, 1938. Mr. Warner was born February 14, 1896, at Freeport, Ill., and received the degrees of bachelor of arts (1917), master of arts (1921), and master of science in electrical engineering (1925) at Washburn College, University of Kansas, and Union College, respectively. Following his graduation in 1917 he joined the Signal Corps of the United States Army, remaining in that service until 1919, when he was appointed instructor in physics at the University of Kansas. In the following year he was appointed assistant physicist in the National Bureau of Standards at Washington, D. C., but shortly thereafter obtained a position in the research laboratory of the General Electric Company, Schenectady, N. Y. In 1931 he was appointed assistant head of the vacuum-tube engineering department of that company and one year later became manager of the research and development laboratory of the RCA Radiotron Company. He became vice-president in 1934.

Herbert Mygatt Wilcox (M'37) manager of the new-products division of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., died suddenly July 28, 1938, while he was in New York City on business. Mr. Wilcox was born at Pittsburgh, Pa., November 6, 1882. After attending Princeton University from 1900 to 1902 he transferred to Massachusetts Institute of Technology, from which he was graduated in 1905 with the degree of bachelor of science in chemical engineering. In 1914 he joined the Winchester Repeating Arms Company, serving as an industrial engineer until 1925, when he became vice-president of Electrical Research Products, Inc. In 1936 he resigned to join Paramount Pictures Corporation, and in the following year became associated with the Westinghouse Company.

Walter J. Lackie (A'28) Doble Engineering Company, Medford Hillside, Mass., died May 26, 1938. Mr. Lackie was born January 20, 1875, at Lowell, Mass., and in 1905 became a station operator for J. E. Henry and Sons, Lincoln, N. H. Three years later he became a draft man for the Manchester (N. H.) Traction, Light, and Power Company, and during the World War was master signal electrician in the United States Army. At the end of the War he became a designer for French and Hubbard, Boston, Mass. In 1922 Mr. Lackie joined the staff of the Doble Engineering Company, and except for one year with Stone and Webster he remained with that organization continuously.

William Joseph Dalton (A'24) electrical diagram division of the general drafting bureau, mechanical engineers department, Consolidated Edison Company of New York, Inc., New York, N. Y., died July 9, 1938. Mr. Dalton was born July 18, 1894, in New York. In 1915 he was employed by The New York Edison Company as assistant meter tester, and except for a period of service in the Air Corps of the United States Army during the World War, his employment with the predecessors and affiliated companies of the Consolidated Edison Company was continuous.

Douglas Lyle Furness (A'08) a sales engineer in the industrial department of the General Electric Company, Boston, Mass., died suddenly June 19, 1938. Mr. Furness was born March 16, 1883, at Rochester, N. Y., and was graduated from Harvard University with the degrees of bachelor of arts (1904) and bachelor of science (1905). Immediately following his graduation in 1905 he entered the employ of the General Electric Company as a test engineer. He was engaged in various sales activities of the company for almost 30 years.

Walter Edwin Young (A'19, M'19) manager of the apparatus sales department, Canadian General Electric Company, Ltd., Toronto, Ont., died June 22, 1938. Mr. Young was born in Toronto, May 28, 1886, and received his technical education at the Toronto Technical School. For four years he was associated with the United Electric Company, Ltd. He then joined the Canadian General Electric Company, where he remained for 32 years.

William Morris Mordey (A'91) consulting engineer, London, England, died July 1, 1938, at the age of 82, after a lifetime spent in the development of electromagnetic machinery. During 1908–09 Mr. Mordey was president of the Institution of Electrical Engineers. He was actively engaged in electrical engineering in England and abroad for 56 years. He was the author of numerous scientific papers.

Membership

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before September 30, 1938, or November 30, 1938, if the applicant resides outside of the United States or Canada.

United States and Canada

Borda, I. W. (Member), Okonite Company, San Francisco, Calif.
Carter, K. G., Utah Power and Light Company, Salt Lake City.
Ein, S., 907 May Street, Hammond, Ind.
Fisher, L. T., United States Engineering Department, Bonneville, Ore.
Hagerty, J. M. J., Memphis Light and Water Division, Memphis, Tenn.
Hancock, E. A. (Member), General Electric Company, Boston, Mass.
Hanley, J. P., Jr. (Member), Florida Power and Light Company, West Palm Beach.
Hudson, A. B., Louisiana Power and Light Company, Sterlington.
Laskey, M. J., Jr., 1101 Yeadon Avenue, Yeadon, Pa.
Leho, H., 4891 Ogden Street, Detroit, Mich.
Maughmer, G. F., General Electric Company, Los Angeles, Calif.
McIntyre, H. B. (Member), New England Telephone and Telegraph Company, Boston, Mass.
Moore, A. J., General Electric Company, Boston, Mass.
Morgenegg, A. W., General Service Company, Idaho Falls, Idaho.
Murphy, M. (Member), Southwestern Gas and Electric Company, Fayetteville, Ark.
Nace, A. S., Radiart Corporation, Cleveland, Ohio.
Nettleton, F. P., Southern New England Telephone Company, New Haven, Conn.
Pringle, J. A., (Member), General Motors, Air Conditioning Division, Hackensack, N. J.
Ricketts, G. B. S., c/o Scott and Bres, New Orleans, La.
Sledd, M. B., General Electric Company, Schenectady, N. Y.
Snadyc, A. M., Jr., 214 Ackerman Avenue, Clifton, N. J.
Symonds, R. F. (Member), New England Trawler Equipment Company, East Boston, Mass.
Woodsmall, F. J., Jensen Radio Manufacturing Company, Chicago, Ill.

Total, United States and Canada—23

Elsewhere

Hansson, B. N. (Fellow), Liljeholmens Kabelfabrik, Stockholm 9, Sweden.
Prowse, R. M. (Member), Tata Iron and Steel Company Ltd., Jamshedpur, India.
Sillar, L. G. (Member), Malakand Hydro Electric Scheme, Mardan, N.W.F. Province, India.
Spaethy, E. S., Compania Minera de Oruro, Oruro, Bolivia, S. A.

Total elsewhere—4

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the addresses as they now appear on the Institute record. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Ackerson, Cornelius, 2600 West Grand Boulevard, Detroit, Mich.
Barrett, Earl J., Don Pedro Dam, La Grange, Calif.
Cervenka, Frank J., 5736 Midway Park, Chicago, Ill.
De Lay, R. E., 77 Prospect Ave., Long Beach, Calif.
Fetter, Charles H., Electrical Research Products, 250 W. 57th St., New York, N. Y.
Kapell, Sidney M., 3043 Emmons Ave., Brooklyn, N. Y.
Markham, Thomas C., Jr., 55 Hanson Place, Brooklyn, N. Y.
Marshall, Myron B., Jr., 606 State St., Schenectady, N. Y.
Neiman, William E., 4060 Elbertson Street, Elmhurst, N. Y.
Nissar, A. R., in care of Thomas Cook and Son, 2 Place de la Madeleine, Paris, France.
Piltch, Abraham, 2224 Eutaw Place, Baltimore, Md.
Platterer, Alvin, 776 N. Cass St., Milwaukee, Wis.
Powers, Walter H., 603 West Washington, Jackson, Mich.
Renking, H. L., 208 N. Broadway, St. Louis, Mo.
Robison, R. L., 941 E. Northlake Ave., Seattle, Wash.
Shimp, Robert P., 414 Hampton Ave., Wilkinsburg, Pa.
Skina, Fred A., 626 Ash St., Moscow, Idaho.
Thrush, George H., Jr., 595 Union Trust Bldg., Pittsburgh, Pa.
Whitney, T. G., Electrical Research Products, Inc., 250 W. 57th St., New York, N. Y.
Willick, Francis L., 2397 East Grand Boulevard, Detroit, Mich.
Wilson, Alexander, 315 New Birks Bldg., Montreal, Que., Can.

21 Addresses Wanted

Engineering Literature

New Books in the Societies Library

Among the new books received at the Engineering Society Library, New York, recently are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface of the book in question.

INTRODUCTION to COLLEGE PHYSICS. By C. M. Kilby. Second Edition New York, D. Van Nostrand Company, 1938. 398 pages, illustrated, 9 by 6 inches, cloth, $3.25. Intended to present a brief course in the fundamentals of physics. The arrangement of material is orthodox. Contains five main sections on mechanics, sound, heat, magnetism and electricity, and light.

HOUSEHOLD ELECTRIC REFRIGERATION. By J. F. Wostrel and J. G. Praetz. New York and London, McGraw-Hill Book Company, 1938. 406 pages, illustrated 9 by 6 inches, cloth, $4.00. A practical manual for refrigeration service men, electricians, salesmen and others interested in the operation, construction, adjustment and servicing of household refrigerators and their control devices.

FUNDAMENTALS of ELECTRICAL ENGINEERING. By M. B. Reed. Scranton, International Textbook Company, 1938. 326 pages, illustrated, 9 by 5 inches, leather, $3.00. An elementary textbook covering the customary electrical quantities and phenomena, including chapters on transients and conduction through gases. In the treatment of electric circuits the double-subscript method now in use for a-c circuits is applied to direct currents.

ELEMENTS OF PHYSICS. By A. W. Smith. Fourth edition New York and London, McGraw-Hill Book Company, 1938. 790 pages, illustrated, 9x6 inches, cloth, $3.75. A revision of a standard textbook on physics, covering mechanics, wave motion and sound, heat, magnetism and electricity, electronics, physical and geometrical optics, radiation and atomic structure. Two new chapters are devoted to nuclear physics and astrophysics.

ELEKTROINSTALLATION in der SIEDLUNG. Vorbilder und Richtlinien für die Klein-, Gärtner- und Bauernsiedlung, edited by Fachausschuss für Haustechnik des VDI. Berlin, VDI-Verlag, 1938. 58 pages, illustrated, 8 by 6 inches, paper, 2 rm. Discusses the proper planning, layout, erection, and design of details for the current distribution system of small villages or farm settlements, including equipment for electrical lighting, heating, and power installations.

ELECTRIC WELDING. By M. H. Potter. Chicago, American Technical Society, 1936. 77 pages, illustrated, 9 by 6 inches, cloth, $1.25. A practical book for the inexperienced welder, describing processes and equipment, methods for various metals, shapes and types of work, the weldability of different metals, and certain special jobs. The last chapter covers power-tube rectifiers and their utilization in welding equipment.

LIST of RETIREMENT UNITS for ELECTRIC UTILITIES, prepared by Committee on Statistics and Accounts of Public Utility Companies of National Association of Railroad and Utilities Commissioners. New York, State Law Reporting Company, 1937. 21 pages, mimeographed, 11 by 9 inches, paper, $0.85; bound $1.00. A supplement to the uniform system of accounts for electric Utilities. Its purpose is to create greater uniformity in accounting for replacements of property and for depreciation by providing more accurate and uniform distinction between replacements which should be classed as property additions and those to be classed as maintenance.

MOTION PICTURE SOUND ENGINEERING, a Series of Lectures presented to the classes enrolled in the courses in Sound Engineering given by the Research Council of the Academy of Motion Picture Arts and Sciences, Hollywood, Calif. New York, D. Van Nostrand Co., 1938. 547 pages, illustrated, $9^1/_2$ by 6 inches, cloth, $6.00. Material is taken from a series of lectures presented to employees of motion picture studios. Subjects vary from discussions of sound, electricity, and the chemical elements, through the mechanical processes of recording and projecting, to technical descriptions of filters, networks, and amplifiers.

HEARING, Its Psychology and Physiology. By S. S. Stevens and H. Davis. New York, John Wiley and Sons, 1938. 489 pages, illustrated, 9 by 6 inches, leather, $4.50. Discusses fundamentals of the science of sound, analyzes the auditory process, and describes the systematic relations between stimulus and sensation. Offers also a study of the functional anatomy and physiology of the ear.

ELEMENTS of MECHANISM. By P. Schwamb, A. L. Merrill and W. H. James. Fifth edition. New York, John Wiley and Sons, 1938. 400 pages, diagrams, charts, tables, 9 by 6 inches, cloth, $3.50. Intended to give familiarity with the application of the fundamental principles of kinematics in the field of mechanical movements. Discusses vectors, velocity analysis, motion transmission, and the characteristics of transmitters of mechanical power.

ELEMENTARY THERMODYNAMICS. By V. M. Faires. New York, Macmillan Company, 1938. 225 pages, illustrated, 9 by 6 inches, leather, $2.60. A presentation of the topics of importance for short courses in thermodynamics.

PRINCIPLES of ENGINEERING ECONOMY. By E. L. Grant. Revised edition. New York, Ronald Press Company, 1938. 431 pages, diagrams, charts, tables, 8 by 6 inches, cloth, $3.75. Demonstration of a practical technique providing an engineering basis for making economic decisions is the purpose of this book. Explains interest, valuation, and rate of return calculations and discusses the making of estimates for new enterprises, replacement problems, and the planning of future developments.

(The) MIND of the ANCIENT WORLD. By H. N. Wethered. New York, Longmans, Green and Company, 1937. 302 pages, tables, 9 by 6 inches, cloth, $4.00. A review of Pliny's "Natural History," presenting many excerpts from a famous Elizabethan translation with critical comment by the author.

FOUNDATIONS of WIRELESS. By A. L. M. Sowerby. Second edition. London, (The) Wireless World, Iliffe and Sons, Ltd., 1937. 266 pages, illustrated, 8 by 5 inches, cloth, 4s. 6d. plus 5d. postage. An elementary textbook on radio fundamentals and the radio receiver in particular. Discusses circuits, tubes, and the process of detection, and contains new material on negative feedback, automatic tuning and automatic selectivity control.

ESSAYS in SCIENCE and ENGINEERING, compiled by F. Montgomery and L. N. Becklund. Revised edition. New York, Farrar and Rinehart, 1938. 523 pages, charts, tables, 9 by 6 inches, cloth, $2.00. A collection of essays and articles on scientific and technical subjects designed to provide reading material for engineering English courses. The first part comprises a selection of more general essays; the second and larger part consists of "expository models" for various kinds of technical composition.

DIRECT and ALTERNATING CURRENTS, Theory and Machinery. By E. A. Loew. Second edition. New York and London, McGraw-Hill Book Company, 1938. 730 pages, illustrated, 9 by 6 inches, cloth, $4.50. Intended primarily for students desiring a short survey course in the theory of the electric circuit and the operating principles of electric machines. Stresses fundamental principles rather than mere factual information. A-C theory is stressed largely in terms of vectors. Mathematical discussions are omitted or reduced to simple forms.

Engineering Societies Library

39 West 39th Street, New York, N. Y.

MAINTAINED as a public reference library of engineering and the allied sciences, this library is a co-operative activity of the national societies of civil, electrical, mechanical, and mining engineers.

Resources of the library are available also to those unable to visit it in person. Lists of references, copies or translation of articles, and similar assistance may be obtained upon written application, subject only to charges sufficient to cover the cost of the work required.

A collection of modern technical books is available to any member residing in North America at a rental rate of five cents per day per volume, plus transportation charges.

Many other services are obtainable and an inquiry to the director of the library will bring information concerning them.

Officers and Committees for 1938-39

Officers

President

JOHN C. PARKER	New York, N. Y.

(Term expires July 31, 1939)

Junior Past-Presidents

A. M. MACCUTCHEON	Cleveland, Ohio

(Term expires July 31, 1939)

W. H. HARRISON	New York, N. Y.

(Term expires July 31, 1940)

Vice-Presidents

Dist. No.		
2	I. MELVILLE STEIN	Philadelphia, Pa.
4	EDWIN D. WOOD	Louisville, Ky.
6	L. N. McCLELLAN	Denver, Colo.
8	J. P. JOLLYMAN	San Francisco, Calif.
10	M. J. McHENRY	Toronto, Ont.

(Terms expire July 31, 1939)

1	CHESTER L. DAWES	Cambridge, Mass.
3	F. M. FARMER	New York, N. Y.
5	A. H. LOVELL	Ann Arbor, Mich.
7	F. C. BOLTON	College Station, Tex.
9	LESTER R. GAMBLE	Spokane, Wash.

(Terms expire July 31, 1940)

Directors

F. ELLIS JOHNSON	Madison, Wis.
C. R. JONES	New York, N. Y.
W. B. KOUWENHOVEN	Baltimore, Md.

(Terms expire July 31, 1939)

K. B. McEACHRON	Pittsfield, Mass.
C. A. POWEL	East Pittsburgh, Pa.
R. W. SORENSEN	Pasadena, Calif.

(Terms expire July 31, 1940)

C. R. BEARDSLEY	New York, N. Y.
VANNEVAR BUSH	Cambridge, Mass.
F. H. LANE	Chicago, Ill.

(Terms expire July 31, 1941)

L. R. MAPES	Chicago, Ill.
H. S. OSBORNE	New York, N. Y.
D. C. PRINCE	Philadelphia, Pa.

(Terms expire July 31, 1942)

National Treasurer

W. I. SLICHTER	New York, N. Y.

(Term expires July 31, 1939)

National Secretary

H. H. HENLINE	New York, N. Y.

(Term expires July 31, 1939)

General Counsel

Parker & Aaron
20 Exchange Place, New York, N. Y.

Local Honorary Secretaries

AUSTRALIA—V. J. F. Brain, Dept. of Works & Local Govt., Bridge St., Sydney, N. S. W.

BRAZIL, S. A.—F. M. Servos, Rio de Janeiro Tramways Light & Power Co., Rio de Janeiro.

ENGLAND—A. P. M. Fleming, Metropolitan Vickers Electric Co., Trafford Park, Manchester.

FRANCE—A. S. Garfield, 173 Boulevard Haussmann, Paris, 8E.

INDIA, NORTHERN—V. F. Critchley, P.W.D., Electricity Branch, Lahore, Punjab, India.

INDIA, SOUTHERN—N. N. Iengar, The Tata Power Co. Ltd., Bombay House, Fort Bombay, India.

ITALY—Renzo Norsa, Piazza Irnerio 8, Milano.

NEW ZEALAND—P. F. Powell, Canterbury College, Christchurch.

SWEDEN—A. F. Enstrom, Ingeniorsvetenskrapsakademien, Stockholm.

TRANSVAAL, AFRICA—W. Elsdon-Dew, P. O. Box 4563, Johannesburg.

General Committees

Executive

John C. Parker, Chm., 4 Irving Place, New York, N. Y.
F. M. Farmer
W. H. Harrison
C. R. Jones
A. M. MacCutcheon
K. B. McEachron
W. I. Slichter

Board of Examiners

F. V. Magalhaes, Chm., Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York, N. Y.
H. E. Farrer, Secy., AIEE, 33 W. 39th St., New York, N. Y.
P. H. Adams
F. E. D'Humy
Harold Goodwin, Jr.
H. A. Kidder
A. E. Knowlton
H. E. Shreeve
R. H. Marriott
Alexander Maxwell
A. G. Oehler
A. L. Powell
D. C. Prince

Code of Principles of Professional Conduct

D. C. Jackson, Chm., 5 Mercer Circle, Cambridge, Mass.
H. V. Carpenter
F. B. Jewett
A. M. MacCutcheon
W. M. Piatt
H. T. Plumb
C. E. Stephens

Columbia University Scholarships

W. I. Slichter, Chm., Columbia University, New York, N. Y.
Francis Blossom
H. C. Carpenter

Constitution and By-Laws

L. W. W. Morrow, Chm., Corning Glass Works, Corning, N. Y.
R. N. Conwell
H. A. Kidder
I. Melville Stein
Everett S. Lee
W. I. Slichter

Economic Status of the Engineer

A. H. Lovell, Chm., University of Michigan, Ann Arbor, Mich.
T. F. Barton
C. O. Bickelhaupt
F. M. Feiker
R. W. Sorensen

Edison Medal

Appointed by the President for term of 5 years

H. B. Gear L. W. W. Morrow, Chm. J. B. Whitehead
(Terms expire July 31, 1939)
F. J. Meyer R. A. Millikan Marion Penn
(Terms expire July 31, 1940)
G. L. Knight H. W. Osgood W. S. Rodman
(Terms expire July 31, 1941)
C. R. Jones Everett S. Lee H. S. Osborne
(Terms expire July 31, 1942)
J. W. Barker N. E. Funk W. H. Harrison
(Terms expire July 31, 1943)

Appointed by the Board of Directors from its own membership for term of 2 years

C. R. Beardsley A. M. MacCutcheon K. B. McEachron
(Terms expire July 31, 1939)
C. L. Dawes A. H. Lovell R. W. Sorensen
(Terms expire July 31, 1940)

Ex-officio
John C. Parker, President
W. I. Slichter, National Treasurer
H. H. Henline, National Secretary
(Terms expire July 31, 1939)

Finance

C. R. Jones, Chm., Westinghouse Elec. & Mfg. Co., 150 Broadway, New York, N. Y.
F. M. Farmer
D. C. Prince

Headquarters

O. B. Blackwell, Chm., 463 West St., New York, N. Y.
H. H. Henline
C. R. Jones

Institute Policy

A. M. MacCutcheon, Chm., 1088 Ivanhoe Road, Cleveland, Ohio
C. F. Harding
W. H. Harrison
B. D. Hull
H. S. Osborne
I. Melville Stein
W. H. Timbie
J. B. Whitehead
H. R. Woodrow

Iwadare Foundation

F. B. Jewett, Chm., 195 Broadway, New York, N. Y.
J. W. Barker
H. H. Barnes, Jr.

Lamme Medal

V. Bush, Chm. C. R. Jones D. C. Prince
(Terms expire July 31, 1939)
F. J. Chesterman C. F. Hirshfeld A. H. Kehoe
(Terms expire July 31, 1940)
E. W. Allen A. C. Flory W. B. Kouwenhoven
(Terms expire July 31, 1941)

Legislation Affecting the Engineering Profession

J. B. Thomas, Chm., Texas Electric Service Co., Fort Worth, Tex.
T. F. Barton
C. R. Beardsley
S. E. Caldwell
D. T. Canfield
O. J. Ferguson
N. E. Funk
Fred Garrison
F. G. Guldi
F. M. Gunby
D. C. Jackson
L. S. Ready
R. L. Thomas
J. M. Todd
W. K. Vanderpoel

Membership

R. L. Webb, Chm., Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York, N. Y.
T. F. Ball
F. C. Bolton
R. O. Brosemer
P. G. Edwards
C. E. Winn
L. G. Hamilton
G. L. Hoard
G. A. Kositzky
F. H. McClain

District Vice-Chairmen

C. M. Foust (1)
M. W. Smith (2)
O. C. Brill (3)
A. S. Anderson (4)
C. A. Cora (5)
Nelson R. Love (6)
F. J. Meyer (7)
F. B. Doolittle (8)
C. C. Boozier (9)
A. B. Cooper (10)

Ex-officio
Chairmen of membership committees of all Sections

Planning and Co-ordination

F. M. Farmer, Chm., Electrical Testing Laboratories, 80th St. & East End Ave., New York, N. Y.
R. E. Hellmund
H. H. Henline
C. R. Jones
I. Melville Stein
L. W. W. Morrow
H. S. Osborne
H. H. Race

Prizes, Award of Institute

H. S. Osborne, Chm., American Tel. & Tel. Co., 195 Broadway, New York, N. Y.
J. W. Barker
I. Melville Stein
E. C. Crittenden

Publication

I. Melville Stein, Chm., Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.
F. A. Lewis, Secy., AIEE, 33 W. 39th St., New York, N. Y.
J. W. Barker
O. W. Eshbach
H. H. Henline
A. G. Oehler
M. W. Smith
H. S. Osborne
H. S. Phelps
H. H. Race
D. M. Simmons

GENERAL COMMITTEES—Continued

Safety

Wills Maclachlan, Chm., 50 Oakwood Ave., Toronto, Ont.

L. F. Adams
Mark Eldredge
J. B. Fisken
F. D. Knight
W. B. Kouwenhoven
M. G. Lloyd
F. V. Magalhaes
C. N. Rakestraw
A. R. Small
Frank Thornton, Jr.
W. C. Wagner
H. S. Warren
H. H. Weber

Sections

H. H. Race, Chm., Research Laboratory, General Electric Co., Schenectady, N. Y.
M. S. Coover, Secy., Dept. of Elec. Engg., Iowa State College, Ames, Iowa

W. M. Dann
O. W. Holden
E. T. Mahood
I. Melville Stein
W. H. Timbie

Ex-officio

Chairmen of all Institute Sections

Standards

R. E. Hellmund, Chm., Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
H. E. Farrer, Secy., AIEE, 33 W. 39th St., New York, N. Y.

W. P. Dobson
F. M. Farmer
C. R. Harte
R. T. Henry
A. H. Kehoe
J. Franklin Meyer
V. M. Montsinger
E. L. Moreland
S. H. Mortensen
E. B. Paxton
R. L. Young

Ex-officio

Chairmen of Working Committees
Chairmen of AIEE delegations on other standardizing bodies or sole representative thereon
President of U.S. National Committee of the International Electrotechnical Commission

Student Branches

R. W. Sorensen, Chm., California Institute of Technology, Pasadena, Calif.

R. H. Dearborn
E. E. Dreese
W. C. DuVall
G. A. Irland
F. Ellis Johnson
C. W. Ricker
Charles F. Scott
E. M. Strong

Ex-officio

Student Branch Counselors

Technical Program

H. S. Osborne, Chm., American Tel. & Tel. Co., 195 Broadway, New York, N. Y.
C. S. Rich, Secy., AIEE, 33 W. 39th St., New York, N. Y.

C. R. Beardsley
H. S. Bennion
A. H. Lovell
V. M. Montsinger
L. W. W. Morrow
E. J. O'Connell
M. W. Smith
I. Melville Stein
T. A. Worcester

Ex-officio

F. M. Farmer, Chairman, Committee on Planning and Co-ordination
Wills Maclachlan, Chairman, Committee on Safety
Chairmen of all technical committees

Transfers

Everett S. Lee, Chm., General Electric Co., Schenectady, N. Y.

F. M. Craft
H. C. Don Carlos
F. M. Farmer
Harold Goodwin, Jr.
F. O. McMillan
E. L. Moreland

Technical Committees

Automatic Stations

H. W. Codding, Chm., Public Service Electric & Gas Co., 80 Park Place, Newark, N. J.

F. F. Ambuhl
A. E. Anderson
Raymond B. Arthur
A. M. de Bellis
F. S. Douglass
W. W. Edson
Joseph Hellenthal
F. H. Lane
J. T. Logan
L. N. McClellan
G. E. Northup
A. P. Peterson
C. F. Publow
M. E. Reagan
O. J. Rotty
Fred E. Snell
Garland Stamper
L. J. Turley
Chester Wallace
H. B. West
W. C. Whitman

Basic Sciences

E. E. Dreese, Chm., Ohio State University, Columbus, Ohio

S. S. Attwood
A. Boyajian
W. F. Davidson
L. O. Grondahl
C. R. Hanna
H. L. Hazen
V. Karapetoff
M. J. Kelly
H. P. Lawther, Jr.
F. C. Lindvall
M. G. Malti
K. B. McEachron
K. W. Miller
G. W. Penney
H. H. Race
J. Slepian
K. Y. Tang
J. D. Tebo
A. von Hippel
Ernst Weber

Liaison Representatives of American Physical Society

Harvey L. Curtis
Leigh Page

Communication

W. L. Everitt, Chm., Ohio State University, Columbus, Ohio
E. J. O'Connell, Secy., American Tel. & Tel. Co., 195 Broadway, New York, N. Y.

H. A. Affel
C. B. Aiken
A. L. Albert
W. C. Ballard, Jr.
H. H. Beverage
Edward L. Bowles
Charles B. Carpenter
L. W. Chubb
John L. Clarke
J. B. Coleman
H. J. Dible
Melville Eastham
E. E. George
G. H. Gray
W. F. Grimes
C. B. Jolliffe
H. E. Kent
J. R. MacGregor
S. S. Mackeown
L. R. Mapes
John R. Martin
F. R. McBerty
H. J. Pierce
H. Pratt
C. E. Rogers
Walter G. Rubel
M. A. Sawyer
E. R. Shute
Arthur Bessey Smith
Burke Smith
D. F. Smith
H. W. Sundius
A. Hoyt Taylor
C. H. Taylor
F. E. Terman
H. M. Turner
M. P. Weinbach
W. C. White
F. A. Wolff
F. C. Young
V. K. Zworykin

Education

J. W. Barker, Chm., Columbia University, New York, N. Y.

Robin Beach
H. W. Bibber
F. C. Bolton
H. V. Carpenter
M. S. Coover
E. E. Dreese
A. M. Dudley
O. W. Eshbach
C. F. Harding
F. Ellis Johnson
A. S. Langsdorf
W. J. Miller
A. D. Moore
E. L. Moreland
R. C. Putnam
J. W. Ramsay
A. R. Stevenson, Jr.
E. M. Strong
F. E. Terman
N. L. Towle
H. N. Walker
R. I. Wilkinson

Electric Welding

W. E. Crawford, Chm., A. O. Smith Corp., Milwaukee, Wis.

C. A. Adams
J. H. Blankenbuehler
A. M. Candy
J. W. Dawson
Saul Dushman
D. D. Ewing
K. L. Hansen
E. A. Hester
H. M. Hobart
C. J. Holslag
G. G. Landis
Hermann Lemp
J. C. Lincoln
F. W. Maxstadt
C. L. Pfeiffer
C. A. Powel
Carroll Stansbury
H. E. Stoddard
Malcolm Thomson
E. H. Vedder
H. A. Winne

Electrical Machinery

C. M. Laffoon, Chm., Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa.
J. L. Hamilton, Vice-Chm., 1806 Pine St., St. Louis, Mo.

P. L. Alger
J. E. Clem
C. M. Gilt
I. W. Gross
M. S. Hancock
F. E. Harrell
A. P. Hayward
F. Ellis Johnson
O. K. Marti
V. M. Montsinger
T. H. Morgan
S. H. Mortensen
F. L. Moser
J. R. North
F. D. Phillips
H. V. Putman
P. H. Rutherford
C. C. Shutt
J. B. Swering
B. R. Teare
B. Van Ness, Jr.
G. A. Waters

Electrochemistry and Electrometallurgy

M. F. Skinker, Chm., Consolidated Edison Co. of New York, Inc., 55 Johnson St., Brooklyn, N. Y.

J. V. Alfriend, Jr.
F. V. Andreae
E. L. Bailey
C. Dantsizen
C. L. Dudley
F. W. Godsey, Jr.
W. C. Kalb
W. B. Kouwenhoven
C. C. Levy
Allan Monkhouse
J. D. Noyes
R. M. Pfalzgraff
F. O. Schnure
W. R. Schofield
N. R. Stansel
C. P. Yoder

Industrial Power Applications

J. D. Wright, Chm., General Electric Co., Schenectady, N. Y.

(Personnel not completed at time of publication)

Instruments and Measurements

H. C. Koenig, Chm., Electrical Testing Laboratories, 80th St. & East End Ave., New York, N. Y.

C. E. Bathe
T. M. Blakeslee
P. A. Borden
H. B. Brooks
A. L. Brownlee
C. T. Burke
J. S. Cruikshank
E. D. Doyle
W. N. Goodwin, Jr.
C. H. G. Gray
T. S. Gray
S. S. Green
H. C. Hamilton
N. S. Hibshman
F. C. Holtz
I. F. Kinnard
A. E. Knowlton
W. B. Kouwenhoven
Everett S. Lee
L. J. Lunas
Paul MacGahan
H. B. Pratt
H. W. Price
H. C. Rankin
E. J. Rutan
W. J. Shackelton
G. M. L. Sommerman
H. L. Thomson
H. M. Turner
H. N. Walker
Joseph Weil
R. J. Wiseman

Light, Production and Application of

Robin Beach, Chm., Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn, N. Y.

D. W. Atwater
J. W. Barker
S. K. Barrett
W. T. Blackwell
H. B. Dates
E. E. Dorting
C. L. Dows
L. R. Gamble
C. A. B. Halvorson, Jr.
L. A. Hawkins
S. G. Hibben
H. H. Higbie
W. C. Kalb
R. D. Mailey
P. S. Millar
L. C. Porter
A. L. Powell
E. M. Strong
I. A. Yost

Marine Work, Applications to

A. Kennedy, Jr., Chm., General Electric Company, Schenectady, N. Y.

E. C. Alger
R. A. Beekman
H. C. Coleman
H. F. Harvey, Jr.
C. J. Henschel
F. C. Hoelzle
I. H. Osborne
G. A. Pierce
C. A. Powel
W. H. Reed
H. M. Southgate
W. E. Thau
A. E. Waller
O. A. Wilde
J. L. Wilson
R. J. Wiseman
R. L. Witham
W. N. Zippler

Power Generation

Edward C. M. Stahl, Chm., Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York, N. Y.

(Personnel not completed at time of publication)

TECHNICAL COMMITTEES—Continued

Power Transmission and Distribution

R. D. Evans, Chm., Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Raymond Bailey
A. E. Bauhan
D. K. Blake
M. O. Bolser
A. B. Campbell
J. S. Carroll
C. V. Christie
Harold Cole
C. A. Corney
M. T. Crawford
A. E. Davison
G. E. Dean
F. W. Deck
Mark Eldredge
D. D. Ewing
E. D. Freeman
Herman Halperin
Edwin Hansson
K. A. Hawley
L. F. Hickernell
J. P. Jollyman
W. W. Lewis
E. A. Loew
J. T. Lusignan, Jr.
G. R. Milne
E. W. Oesterreich
J. S. Parsons
H. J. Scholz
G. B. Shanklin
A. E. Silver
D. M. Simmons
C. T. Sinclair
L. G. Smith
Philip Sporn
P. B. Stewart
Stanley Stokes
J. J. Torok
H. M. Trueblood
W. K. Vanderpoel
C. F. Wagner
H. S. Warren
L. F. Woodruff
T. A. Worcester
H. E. Wulfing

Protective Devices

K. B. McEachron, Chm., General Electric Company, 100 Woodlawn Ave., Pittsfield, Mass.

E. H. Bancker
H. D. Braley
W. R. Brownlee
J. O'R. Coleman
H. W. Collins
F. R. Ford
G. W. Gerell
I. W. Gross
Herman Halperin
F. C. Hanker
R. T. Henry
P. A. Jeanne
B. M. Jones
R. A. Larner
T. G. LeClair
W. A. Lewis
H. J. Lingal
M. G. Lloyd
F. R. Longley
J. R. McFarlin
C. W. McGill
J. P. McKearin
J. W. Milnor
C. A. Muller
J. H. Neher
J. R. North
D. C. Prince
A. H. Schirmer
H. K. Sels
L. G. Smith
R. M. Smith
H. R. Stewart
H. R. Summerhayes
J. D. Wood

Research

E. C. Crittenden, Chm., National Bureau of Standards, Washington, D. C.

F. W. Atkinson
R. W. Atkinson
L. J. Berberich
Paul L. Betz
A. Boyajian
O. E. Buckley
J. S. Carroll
L. W. Chubb
F. M. Clark
M. S. Coover
W. F. Davidson
M. Eppley
Herman Halperin
F. Hamburger, Jr.
L. A. Hawkins
H. M. Hobart
D. C. Jackson, Jr.
R. J. Wiseman
V. Karapetoff
A. E. Kennelly
W. B. Kouwenhoven
F. O. McMillan
K. W. Miller
N. M. Oboukhoff
T. D. Owens
K. K. Paluev
H. H. Race
W. J. Seeley
John M. Smith
V. G. Smith
G. M. L. Sommerman
T. Spooner
Ernst Weber
A. J. Williams, Jr.
C. H. Willis

Transportation

W. S. H. Hamilton, Chm., New York Central System, 466 Lexington Ave., New York, N. Y.

(Personnel not completed at time of publication)

Institute Representatives

Alfred Noble Prize Committee, ASCE

H. S. Osborne

Am. Assoc. for the Adv. of Science, Council

V. Bush
H. S. Osborne

American Committee on Marking of Obstructions to Air Navigation

G. E. Dean
H. L. Huber

American Engineering Council, Assembly

C. O. Bickelhaupt
C. F. Harding
William McClellan
John C. Parker
C. E. Stephens
H. H. Henline, *Alternate*

American Standards Assoc., Standards Council

A. M. MacCutcheon
V. M. Montsinger
E. L. Moreland

Alternates
R. E. Hellmund
H. H. Henline
H. S. Osborne

American Stds. Assoc., Board of Directors

H. P. Charlesworth

American Year Book, Advisory Board

H. H. Henline

Charles A. Coffin Fellowship and Research Fund Committee

John C. Parker

Committee of Apparatus Makers and Users, NRC

L. F. Adams

Committee on Heat Transmission, NRC

T. S. Taylor

Committee on Low Voltage Hazards, ASSE-Engg. Section, National Safety Council

A. B. Campbell

Electrical Standards Committee, ASA

R. E. Hellmund
V. M. Montsinger
H. S. Osborne

Alternates
H. E. Farrer
E. L. Moreland
E. B. Paxton

Engineering Foundation Board

F. M. Farmer
W. I. Slichter

Engineering Societies Monographs Committee

F. M. Farmer
W. I. Slichter

Engineers' Council for Professional Development

F. Ellis Johnson
L. W. W. Morrow
Charles F. Scott

(*Continued on page 400*)

Geographical District Executive Committees

District	Chairman (Vice-President, AIEE)	Secretary (District Secretary)	Chairman, District Committee on Student Activities
No. 1—North Eastern	C. L. Dawes, Harvard University, Cambridge, Mass.	R. G. Lorraine, General Electric Co., Schenectady, N. Y.	E. M. Strong, Cornell University, Ithaca, N. Y.
No. 2—Middle Eastern	I. Melville Stein, Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.	H. A. Dambly, Philadelphia Electric Co., 900 Sansom St., Philadelphia, Pa.	A. G. Ennis, George Washington University, Washington, D. C.
No. 3—New York City	F. M. Farmer, Electrical Testing Laboratories, 80th St. & East End Ave., New York, N. Y.	George Sutherland, Consolidated Edison Co. of New York, Inc., 4 Irving Place, New York, N. Y.	F. H. Tallman, Cooper Union, New York, N. Y.
No. 4—Southern	Edwin D. Wood, Louisville Gas & Electric Co., 311 W. Chestnut St., Louisville, Ky.	A. S. Hoefflin, Louisville Gas & Electric Co., 311 W. Chestnut St., Louisville, Ky.	E. F. Smith, University of Florida, Gainesville, Fla.
No. 5—Great Lakes	A. H. Lovell, University of Michigan, Ann Arbor, Mich.	A. G. Dewars, Northern States Power Co., 15 S. 5th St., Minneapolis, Minn.	J. H. Bowman, Purdue University, Lafayette, Ind.
No. 6—North Central	L. N. McClellan, U. S. Bureau of Reclamation, 440 Custom House, Denver, Colo.	W. F. McPhail, U.S. Bureau of Reclamation, Custom House, Denver, Colo.	G. H. Sechrist, University of Wyoming, Laramie, Wyo.
No. 7—South West	F. C. Bolton, A. & M. College of Texas, College Station, Tex.	H. C. Dillingham, Box 256, Faculty Exchange, College Station, Tex.	N. D. Rode, A. & M. College of Texas, College Station, Tex.
No. 8—Pacific	J. P. Jollyman, Pacific Gas & Electric Co., 245 Market St., San Francisco, Calif.	A. M. Bohnert, Ohio Brass Co., 1006 Matson Bldg., San Francisco, Calif.	W. G. Angermann, University of Southern California, Los Angeles, Calif.
No. 9—North West	L. R. Gamble, Washington Water Power Co., Spokane, Wash.	H. L. Vincent, E. 916—19th Ave., Spokane, Wash.	A. L. Albert, Oregon State College, Corvallis, Ore.
No. 10—Canada	M. J. McHenry, Canadian General Electric Co., 212 King St. W., Toronto, Ont.	J. M. Thomson, Ferranti Electric Ltd., Mount Dennis, Toronto, Ont.	

Note: Each District executive committee includes also the chairmen and secretaries of all Sections within the District, and the District vice-chairman of the national membership committee.

INSTITUTE REPRESENTATIVES—Continued

Hoover Medal Board of Award

H. H. Barnes, Jr.
Gano Dunn
Wm. McClellan

John Fritz Medal Board of Award

A. W. Berresford
A. M. MacCutcheon
W. H. Harrison
J. B. Whitehead

Library Board, United Engineering Trustees, Inc.

W. S. Barstow
H. H. Henline, *ex-officio*
W. A. Del Mar
W. I. Slichter

National Bureau of Engineering Registration, Advisory Board

W. I. Slichter

Nat'l Fire Protection Assoc., Electrical Committee

F. V. Magalhaes
H. S. Warren, *Alternate*

National Fire Waste Council

Wills Maclachlan
H. S. Warren

Nat'l Research Council, Division of Engineering & Industrial Research

V. Bush
Everett S. Lee
J. B. Whitehead
H. H. Henline, *ex-officio*

Research Procedure Com., Engg. Foundation

L. W. Chubb

Thomas Alva Edison Foundation

H. H. Barnes, Jr.
Charles F. Scott
L. W. W. Morrow
Clayton H. Sharp

United Engineering Trustees, Inc.

H. P. Charlesworth
F. M. Farmer
H. R. Woodrow

U.S. National Committee of the International Commission on Illumination

Robin Beach
A. E. Kennelly
Clayton H. Sharp

U.S. National Committee of the International Electrotechnical Commission

R. E. Hellmund
V. M. Montsinger
H. S. Osborne

Alternates
H. E. Farrer
E. L. Moreland
E. B. Paxton

Commission of Washington Award

H. B. Gear
G. G. Post

Student Branches of the Institute

Name and Location	District	Counselor (Member of Faculty)
Akron, Univ. of, Akron, Ohio	2	J. T. Walther
Alabama Polytechnic Inst., Auburn, Ala	4	W. W. Hill
Alabama, Univ. of, University, Ala	4	Fred R. Maxwell, Jr.
Arizona, Univ. of, Tucson, Ariz	8	J. C. Clark
Akransas, Univ. of, Fayetteville, Ark	7	A. S. Brown
Armour Inst. of Tech., Chicago, Ill	5	E. H. Freeman
British Columbia, Univ. of, Vancouver, B. C., Can.	10	W. B. Coulthard
Brooklyn, Poly. Inst. of, Brooklyn, N. Y	3	C. C. Whipple
Brown Univ., Providence, R. I	1	F. N. Tompkins
Bucknell Univ., Lewisburg, Pa	2	G. A. Irland
Calif. Inst. of Tech., Pasadena, Calif	8	F. C. Lindvall
Calif., Univ., of Berkeley, Calif	8	Abe Tilles
Carnegie Inst. of Tech., Pittsburgh, Pa	2	G. R. Patterson
Case School of Applied Science, Cleveland, Ohio	2	J. R. Martin
Catholic Univ. of America, Washington, D. C	2	T. J. MacKavanagh
Cincinnati, Univ. of, Cincinnati, Ohio	2	L. R. Culver
Clarkson College of Technology, Potsdam, N. Y	1	A. R. Powers
Clemson Agri. Col., Clemson, S. C	4	S. R. Rhodes
Colorado State Col. of A. & M. Arts, Fort Collins, Colo	6	F. B. Beatty
Colorado, Univ. of, Boulder, Colo	6	H. B. Palmer
Columbia University, New York, N. Y	3	G. T. Harness
Cooper Union, New York, N. Y	3	F. H. Tallman
Cornell Univ., Ithaca, N. Y	1	E. M. Strong
Denver, Univ. of, Denver, Colo	6	B. E. Cohn
Detroit, Univ. of, Detroit, Mich	5	H. O. Warner
Drexel Inst. of Tech., Philadelphia, Pa	2	E. O. Lange
Duke Univ., Durham, N. C	4	W. J. Seeley
Florida, Univ. of, Gainesville, Fla	4	E. F. Smith
George Washington Univ., Washington, D. C	2	A. G. Ennis
Georgia School of Tech., Atlanta, Ga	4	T. W. Fitzgerald
Harvard Univ., Cambridge, Mass	1	J. D. Cobine
Idaho, Univ. of, Moscow, Idaho	9	R. H. Hull
Illinois, Univ. of, Urbana, Ill	5	E. A. Reid
Iowa State Col., Ames, Iowa	5	B. S. Willis
Iowa, Univ. of, Iowa City, Iowa	5	G. F. Corcoran
Johns Hopkins Univ., Baltimore, Md	2	W. B. Kouwenhoven
Kansas State Col., Manhattan, Kansas	7	E. L. Sitz
Kansas, Univ. of, Lawrence, Kansas	7	E. W. Hamlin
Kentucky, Univ. of, Lexington, Ky	4	E. A. Bureau
Lafayette Col., Easton, Pa	2	F. W. Smith
Lehigh Univ., Bethlehem, Pa	2	Wm. H. Formhals
Lewis Inst., Chicago, Ill	5	F. A. Rogers
Louisiana State Univ., Baton Rouge, La	4	M. B. Voorhies
Louisville, Univ. of, Louisville, Ky	4	S. T. Fife
Maine, Univ. of, Orono, Me	1	A. S. Hill
Marquette Univ., Milwaukee, Wis	5	E. W. Kane
Maryland, University of, College Park, Md	2	L. J. Hodgins
Mass. Inst. of Tech., Cambridge, Mass	1	Gordon S. Brown
Michigan Col. of Min. & Tech., Houghton, Mich	5	G. W. Swenson
Michigan State Col., E. Lansing, Mich	5	M. M. Cory
Michigan, Univ. of, Ann Arbor, Mich	5	S. S. Attwood
Milwaukee Sch. of Engg., Milwaukee, Wis	5	E. L. Wiedner
Minnesota, Univ. of, Minneapolis, Minn	5	J. H. Kuhlmann
Mississippi State Col., State College, Miss	4	H. C. Simrall
Missouri Sch. of Mines and Met., Rolla, Mo	7	I. H. Lovett
Missouri, Univ. of, Columbia, Mo	7	C. M. Wallis
Montana State Col., Bozeman, Mont	9	C. F. Bowman
Nebraska, Univ. of, Lincoln, Neb	6	L. A. Bingham
Nevada, Univ. of, Reno, Nev	8	S. G. Palmer
Newark Col. of Engg., Newark, N. J	3	C. H. Stephan
New Hampshire, Univ. of, Durham, N. H	1	L. W. Hitchcock
New Mexico, Univ. of, Albuquerque, N. Mex	7	H. L. Jones
New York, Col. of the City of, New York, N. Y	3	Harry Baum
New York Univ., New York, N. Y	3	H. N. Walker
North Carolina State Col., Raleigh, N. C	4	R. S. Fouraker
North Carolina, Univ. of, Chapel Hill, N. C	4	R. F. Stainback
North Dakota Agri. Col., Fargo, N. D	6	H. S. Rush
North Dakota, Univ. of, Grand Forks, N. D	6	H. F. Rice
Northeastern Univ., Boston, Mass	1	R. G. Porter
Northwestern Univ., Evanston, Ill	5	A. B. Bronwell
Notre Dame, Univ. of, Notre Dame, Ind	5	J. A. Caparo
Ohio Northern Univ., Ada, Ohio	2	
Ohio State Univ., Columbus, Ohio	2	E. E. Kimberly
Ohio Univ., Athens, Ohio	2	W. M. Young
Oklahoma A. & M. Col., Stillwater, Okla	7	Albrecht Naeter
Oklahoma, Univ. of, Norman, Okla	7	C. T. Almquist
Oregon State Col., Corvallis, Ore	9	A. L. Albert
Pennsylvania State Col., State College, Pa	2	P. X. Rice
Pennsylvania, Univ. of, Philadelphia, Pa	2	C. D. Fawcett
Pittsburgh, Univ. of, Pittsburgh, Pa	2	H. E. Dyche
Porto Rico, Univ. of, Mayaguez, P. R	3	
Pratt Institute, Brooklyn, N. Y	3	C. C. Carr
Princeton Univ., Princeton, N. J	2	A. E. Vivell
Purdue Univ., Lafayette, Ind	5	J. H. Bowman
Rensselaer Poly. Inst., Troy, N. Y	1	L. C. Holmes
Rhode Island State Col., Kingston, R. I	1	W. B. Hall
Rice Institute, Houston, Texas	7	J. S. Waters
Rose Poly. Inst., Terre Haute, Ind	5	C. C. Knipmeyer
Rutgers Univ., New Brunswick, N. J	3	P. S. Creager
Santa Clara, Univ. of, Santa Clara, Calif	8	E. F. Peterson
South Carolina, Univ. of, Columbia, S. C	4	T. F. Ball
South Dakota State Col., Brookings, So. Dak	6	W. H. Gamble
So. Dak. State Sch. of Mines, Rapid City, So. Dak	6	J. O. Kammerman
Southern California, Univ. of, Los Angeles, Calif	8	W. G. Angermann
Southern Methodist Univ., Dallas, Texas	7	E. H. Flath
Stanford Univ., Stanford University, Calif	8	H. H. Skilling
Stevens Inst. of Tech., Hoboken, N. J	3	H. C. Roters
Swarthmore Col., Swarthmore, Pa	2	J. D. McCrumm
Syracuse Univ., Syracuse, N. Y	1	C. W. Henderson
Tennessee, Univ. of, Knoxville, Tenn	4	J. G. Tarboux
Texas A. & M. Col., College Station, Texas	7	R. P. Ward
Texas Technological Col., Lubbock, Texas	7	Willard Gray
Texas, Univ. of, Austin, Texas	7	J. W. Ramsay
Tufts Col., Tufts College, Mass	1	E. A. Walker
Tulane University, New Orleans, La	4	C. W. Ricker
Union Col., Schenectady, N. Y	1	G. J. Fiedler
Utah, Univ. of, Salt Lake City, Utah	9	A. L. Taylor
Vermont, Univ. of, Burlington, Vt	1	R. O. Buchanan
Villanova Col., Villanova, Pa	2	H. S. Bueche
Virginia Military Inst., Lexington, Va	4	
Virginia Poly. Inst., Blacksburg, Va	4	Claudius Lee
Virginia, Univ. of, University, Va	4	L. R. Quarles
Washington, State Col. of, Pullman, Wash	9	H. F. Lickey
Washington, Univ. of, Seattle, Wash	9	R. E. Lindblom
Washington Univ., St. Louis, Mo	7	R. S. Glasgow
West Virginia Univ., Morgantown, W. Va	2	A. H. Forman
Wisconsin, Univ. of, Madison, Wis	5	
Worcester Poly. Inst., Worcester, Mass	1	V. Siegfried
Wyoming, Univ. of, Laramie, Wyo	6	G. H. Sechrist
Yale Univ., New Haven, Conn	1	A. G. Conrad

Total........120

Local Sections of the Institute

Name	District	When Organized	Membership Aug. 1, 1938	Chairman	Secretary	Secretary's Address
Akron	2	Aug. 12, '20	76	H. L. Brouse	F. A. Green	B. F. Goodrich Co., Akron, Ohio
Alabama	4	May 22, '29	39	Fred R. Maxwell, Jr.	T. H. Mawson	Commonwealth & Southern Corp., 600 N. 18th St., Birmingham, Ala.
Baltimore	2	Dec. 16, '04	201	G. S. Diehl	H. A. Frey	Locke Insulator Corp., Baltimore, Md.
Boston	1	Feb. 13, '03	410	J. G. Patterson	J. M. Murray	79 Sidney St., Cambridge, Mass.
Central Indiana	5	Jan. 12, '12	123	J. M. Webb	J. G. Harden	Indiana Bell Tel. Co., Indianapolis, Ind.
Chicago	5	1893	697	J. A. Fitts	W. F. Daly	Allis Chalmers Mfg. Co., 135 So. La Salle St., Chicago, Ill.
Cincinnati	2	June 30, '20	182	J. A. Noertker	C. D. Coy	Cincinnati & Suburban Bell Tel. Co., 225 E. 4th St., Cincinnati, Ohio
Cleveland	2	Sept. 27, '07	300	W. C. Kalb	L. K. Stringham	Lincoln Electric Co., Cleveland, Ohio
Columbus	2	Mar. 17, '22	87	H. W. Bibber	N. J. Greene	National Electric Coil Co., Columbus, Ohio
Connecticut	1	Apr. 16, '21	267	F. A. Faron	H. W. Sundius	Southern New England Tel. Co., New Haven, Conn.
Dallas	7	May 18, '28	114	E. B. Robertson	C. W. Mier	Southwestern Bell Tel. Co., Dallas, Texas
Denver	6	May 18, '15	168	A. S. Anderson	J. R. Walker	U. S. Bureau of Reclamation, Denver, Colo.
East Tennessee	4	Sept. 2, '36	102	J. E. Housley	R. W. McEver	2824 Tarlton Ave., Knoxville, Tenn.
Erie	2	Jan. 11, '18	67	R. W. Barrell, Jr	W. D. Bearce	4121 Sassafras St., Erie, Pa.
Florida	4	Jan. 28, '31	68	A. P. Michaels	Joseph Weil	University of Florida, Gainesville, Fla.
Fort Wayne	5	Aug. 14, '08	88	N. L. Winter	C. R. Atkinson	General Electric Co., 1635 Broadway, Fort Wayne, Ind.
Georgia	4	Jan. 14, '04	97	H. G. Harvey	J. M. Flanigen	Georgia Power Co., Atlanta, Ga.
Houston	7	Aug. 7, '28	116	Seth Evans	T. M. Keiller	2406 Broadway, Beaumont, Texas
Iowa	5	June 25, '29	50	George Charlesworth	H. W. Anderson	Iowa State College, Ames, Iowa
Ithaca	1	Oct. 15, '02	47	W. W. Cotner	True McLean	Cornell University, Ithaca, N. Y.
Kansas City	7	Apr. 14, '16	124	R. G. Kloeffler	B. F. Meador	Black & Veatch, 4706 Broadway, Kansas City, Mo.
Lehigh Valley	2	Apr. 16, '21	192	E. F. Weaver	J. E. Treweek	Pennsylvania Power & Light Co., Hazleton, Pa.
Los Angeles	8	May 19, '08	486	David Hall	J. M. Gaylord	306 West Third St., Los Angeles, Calif.
Louisville	4	Oct. 15, '26	50	A. S. Hoefflin	J. M. Houchens	University of Louisville, Belknap Campus, Louisville, Ky.
Lynn	1	Aug. 22, '11	130	E. H. Raddin	L. P. Shildneck	General Electric Co., River Works, Lynn, Mass.
Madison	5	Jan. 8, '09	64	E. D. Ayres	Wm. A. Kuehlthau	3622 Spring Trail, Madison, Wis.
Memphis	4	May 23, '30	53	C. M. McCord	E. J. Biegel	Box 388, Memphis, Tenn.
Mexico	3	June 29, '22	66	C. E. Plumb	C. Santacruz	Apartado 403, Mexico, D. F., Mexico
Michigan	5	Jan. 13, '11	341	R. E. Greene	W. G. Knickerbocker	The Detroit Edison Co., 2000 Second Ave., Detroit, Mich.
Milwaukee	5	Feb. 11, '10	297	W. E. Crawford	Fred Bush	Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Minnesota	5	Apr. 7, '02	83	C. H. Nelson	R. E. Burlingame	Williamson & Williamson, 925 Metropolitan Life Bldg., Minneapolis, Minn.
Montana	9	June 24, '31	39	C. F. Bowman	W. A. Boyer	2921 Edwards St., Butte, Mont.
Muscle Shoals	4	Feb. 18, '38	40	F. E. Bell	Miss M. G. Coyne	Sheffield Hotel, Sheffield, Ala.
Nebraska	6	Jan. 21, '25	58	I. M. Ellestad	O. E. Edison	Station A, Lincoln, Neb.
New Orleans	4	Dec. 8, '33	78	L. T. Frantz	F. E. Johnson	317 Baronne St., New Orleans, La.
New York	3	Dec. 10, '19	3346	A. L. Powell	G. Sutherland	Consolidated Edison Co. of N.Y., Inc., 4 Irving Pl., New York, N.Y.
Niagara Frontier	1	Feb. 10, '25	205	E. J. Rahill	J. H. Milbyer	Buffalo Niagara Elec. Corp., 300 Electric Bldg., Buffalo, N. Y.
North Carolina	4	Mar. 21, '29	78	M. E. Lake	E. C. Dameron	Durham Public Service Co., Durham, N. C.
Oklahoma City	7	Feb. 16, '22	106	G. I. Page	J. L. Jones	1006 Telephone Bldg., 405 No. Broadway, Oklahoma City, Okla.
Philadelphia	2	Feb. 18, '03	580	H. S. Phelps	W. B. Morton	Philadelphia Elec. Co., Edison Bldg., Philadelphia, Pa.
Pittsburgh	2	Oct. 13, '02	503	W. A. Furst	E. W. Oesterreich	Duquesne Light Co., Pittsburgh, Pa.
Pittsfield	1	Mar. 25, '04	166	L. Wetherill	J. L. Cantwell	General Electric Co., Pittsfield, Mass.
Portland	9	May 18, '09	125	C. B. Carpenter	Corbett McLean	Northwestern Elec. Co., Public Service Bldg., Portland, Ore.
Providence	1	Mar. 12, '20	95	R. J. Underwood	O. E. Sawyer	34 Ford St., Providence, R. I.
Rochester	1	Oct. 9, '14	94	C. L. Smith	C. E. Tuites	Mechanics Institute, Rochester, N. Y.
St. Louis	7	Jan. 14, '03	247	L. O. Campbell	E. K. Shively	Union Electric Co. of Missouri, St. Louis, Mo.
San Antonio	7	May 23, '30	37	O. W. Sommers	W. L. Eyres	San Antonio Public Service Co., San Antonio, Texas
San Francisco	8	Dec. 23, '04	457	F. S. Benson	C. V. Fowler	Pacific Tel. & Tel. Co., 140 New Montgomery St., San Francisco, Calif.
Saskatchewan	10	Oct. 14, '25	25	R. W. Jickling	M. L. Haynes	Balfour Technical School, Regina, Sask., Can.
Schenectady	1	Jan. 26, '03	428	C. E. Kilbourne	O. C. Rutledge	General Electric Co., Schenectady, N. Y.
Seattle	9	Jan. 19, '04	156	R. E. Kistler	L. D. Snow	Puget Sound Power & Light Co., Seattle, Wash.
Sharon	2	Dec. 11, '25	79	C. W. Diehl	E. Steinert	Westinghouse Elec. & Mfg. Co., Sharon, Pa.
Spokane	9	Feb. 14, '13	62	H. A. Stingle	H. B. Hodgins	Westinghouse E. & M. Co., S. 158 Monroe St., Spokane, Wash.
Springfield	1	June 29, '22	57	W. O. Henschke	H. D. Griffith	Westinghouse E. & M. Co., 395 Liberty St., Springfield, Mass.
Syracuse	1	Aug. 12, '20	73	W. H. Lawrence	K. N. Cook	2501 Court St., Syracuse, N. Y.
Toledo	2	June 3, '07	78	G. J. Clark	H. R. Daykin	3701 Larchmont Parkway, Toledo, Ohio
Toronto	10	Sept. 30, '03	348	W. J. Gilson	O. W. Titus	Canada Wire & Cable Co., Ltd., Toronto, Ont., Canada
Tulsa	7	Oct. 1, '37	88	R. K. Lane	D. J. Tuepker	Public Service Co. of Oklahoma, Tulsa, Okla.
Urbana	5	Nov. 25, '02	65	W. J. Warren	G. H. Fett	University of Illinois, Urbana, Ill.
Utah	9	Mar. 9, '17	56	J. A. McDonald	A. C. Kelm	Utah Power & Light Co., Salt Lake City, Utah
Vancouver	10	Aug. 22, '11	98	H. J. MacLeod	T. F. Hadwin	B. C. Electric Railway Co., Ltd., Vancouver, B. C., Canada
Virginia	4	May 19, '22	92	J. S. Miller	F. W. Smith	Virginia Electric & Power Co., Richmond, Va.
Washington	2	Apr. 9, '03	280	T. R. Tate	F. M. Defandorf	National Bureau of Standards, Washington, D. C.
Wichita	7	Sept. 16, '37	33	E. E. Powell	W. A. Wolfe	615 No. Delrose Ave., Wichita, Kansas
Worcester	1	Feb. 18, '20	69	T. R. Holton	W. W. Locke	Worcester Polytechnic Institute, Worcester, Mass.
Total 65						

Pamphlet Copies of Papers Available

¶ Limited quantities of pamphlet copies of the technical papers listed, representing surplus stock remaining from recent AIEE conventions and District meetings, are still available.

¶ Copies may be purchased, up to the limit of the present stock, by simply checking the numbers of the papers wanted, filling in the other spaces provided in this coupon, and forwarding the coupon together with the required remittance to AIEE headquarters.

¶ Price: if delivered at Institute headquarters—five cents per copy; if purchased by mail—ten cents per copy.

¶ Orders will be filled in order of receipt.

¶ For those who wish to order only a few copies at a time and who wish to avoid the inconvenience of making small remittances by mail, coupon books are available in one-dollar and five-dollar denominations.

◆

ORDER DEPT., AIEE,
33 West 39th Street,
New York, N. Y.

I enclose $........ for which please send me copies of papers checked (10¢ per copy by mail; 5¢ if delivered at headquarters) and ...... coupon books at $........ each (state whether $1 or $5 denomination).

Name—Please Print

Street & Number

City

State

Papers Presented at North Eastern District Meeting, Lenox, Mass., May 18–20, 1938

No.	Authors	Titles of Papers (Some Shortened)
☐ 38-40	McEachron	*Multiple Lightning Strokes—II
☐ 38-41	Lennox & DeBlieux	*A Direct-Current Transformer
☐ 38-42	LaPierre & Mansfield	*Photoelectric Weft-Straightener Control
☐ 38-44	Sporn & Gross	*Protector-Tube Application and Performance on 132-Kv Lines—II
☐ 38-45	Brosnan	*System Planning and Operation for Voltage Control
☐ 38-46	Benner & Lunge	*Voltage-Regulating-Equipment Characteristics
☐ 38-47	Landis	*Voltage Regulation and Control of Rural Lines
☐ 38-48	Burrell & Appleton	*The Periodic Voltage Survey as a Basis for Distribution Design
☐ 38-49	Rogers	*Regenerative Tension Control for Paper Winders
☐ 38-50	Bendz	*Comparison of Methods of Stopping Squirrel-Cage Induction Motors
☐ 38-51	Von Sothen	*The Application of Capacitors in Industrial Plants
☐ 38-52	Vogel	*Corona Voltages of Typical Transformer Insulation

Papers Presented at Summer Convention, Washington, D. C., June 20–24, 1938

☐ 37-58	Smith & Weygandt	*Double Line-to-Neutral Short Circuit of an Alternator
☐ 37-866	Appleman	*The Cause and Elimination of Noise in Small Motors
☐ 38-53	Calvert	Amplitudes of the MMF Harmonics for Fractional Slot Windings
☐ 38-54	Porter	Positive-Grid Characteristics of Triodes
☐ 38-55	Bewley	Traveling Waves Initiated by Switching
☐ 38-56	Subcomitte Report	Line-Type Lightning-Arrester Performance Data
☐ 38-57	Fonda	The Fundamental Principles of Fluorescence
☐ 38-58	Whitehead	Lightning Protection of 22-Kv Substations
☐ 38-59	Poritsky	Graphical Field-Plotting Methods in Engineering
☐ 38-60	Reagan	A Self-Checking System of Supervisory Control
☐ 38-61	Race	Tests on Oil-Impregnated Paper—III—Fluid Flow
☐ 38-62	Spurck & Strang	A New Multibreak Interrupter for Fast-Clearing Breakers
☐ 38-63	Champe & Von Voigtlander	System Analysis for Petersen Coil Application
☐ 38-64	Gulliksen	A Position Regulator for Paper Slitters
☐ 38-65	Prince & Williams	The Current-Limiting Power Fuse
☐ 38-66	Clem	Application of Capacitance Potential Devices
☐ 38-67	Curry	The Co-ordination of Mathematics and Physics
☐ 38-68	Malti	Mathematics and Physics in Engineering
☐ 38-69	Stanley	An Analysis of the Induction Machine
☐ 38-70	Brownlee & Dent	Remote Control of Network Protectors
☐ 38-71	Bellaschi & Aggers	Radio-Influence Characteristics of Electrical Apparatus
☐ 38-72	Cole	Flashover Characteristics of Transformer Condenser Bushings
☐ 38-73	Terman	Analysis and Design of Harmonic Generators
☐ 38-74	Schelkunoff	Transmission Theory of Spherical Waves
☐ 38-75	Lyman & North	Application of Large Phase-Shifting Transformer
☐ 38-76	Morgan	Co-ordination of Mathematics and Physics With EE Subjects
☐ 38-77	Inglis	Transmission Features of the New Telephone Sets
☐ 38-78	Wahlquist & Taylor	Noise Co-ordination of Rural Power and Telephone Systems
☐ 38-81	Jones	Instruments for the New Telephone Sets
☐ 38-82	Teare	A Course to Develop Facility in Mathematics and Physics
☐ 38-83	Bryant	Co-ordination of Physics With Electrical Engineering
☐ 38-84	Sporn & St. Clair	Tests and Performance of a High-Speed Multibreak Breaker
☐ 38-85	Dickinson	"De-ion" Air Circuit Breakers
☐ 38-86	Sandin	Enclosed Low-Voltage "De-ion" Breaker of High Capacity
☐ 38-87	Treanor	The Wound-Core Distribution Transformer
☐ 38-88	Sorensen	The Economic Status of the Engineer
☐ 38-90	Williams	Combined Thyratron and Tachometer Control of Small Motors
☐ 38-91	Summers	A Static Constant-Current Circuit
☐ 38-92	Hazeltine	Basic Equations for Electric and Sound Radiation
☐ 38-93	Inman & Thayer	Low-Voltage Fluorescent Lamps
☐ 38-94	McDermott	High-Voltage Gaseous and Fluorescent Tubes
☐ 38-95	Pakala	A Memory Attachment for Oscilloscopes
☐ 38-96	Kouwenhoven & Lotz	Absolute Power Factor of Air Capacitors
☐ 38-97	Rusher & Mershon	The Electric Strain Gauge
☐ 38–98	Concordia, Crary & Lyons	Stability Characteristics of Turbine Generators

Papers Presented at Pacific Coast Convention, Portland, Ore., August 9–12, 1938

☐ 38-43	Lightning Arrester Subcom.	Testing and Application of Lightning Arresters
☐ 38-99	Monroe	Electrification of the San Fracnisco-Oakland Bay Bridge Railway
☐ 38-100	Whelchel	Trends in Electrical Equipment in Hydraulic Power Plants
☐ 38-101	McMillan	Polarity Limits of the Sphere Gap
☐ 38-102	Smith	Use of Bismuth Bridge Magnetic Fluxmeter for A-C Fields
☐ 38-103	Shuck	A Variable-Register-Ratio Watt-Hour Meter
☐ 38-104	Thomson	Similitude of Critical Conditions in Ferroresonant Circuits
☐ 38-105	Morris	Application of Copper-Oxide Rectifiers
☐ 38-106	Wagner	Self-Excitation of Induction Motors
☐ 38-107	Ager	Determination of Induction-Motor Performance
☐ 38-108	Dalziel	Static Power Limits of Synchronous Machines
☐ 38-109	Peterson	General Operation of Transmission Line
☐ 38-110	Cozzens & Peterson	Corona Experience on Transmission Line
☐ 38-111	Cozzens	Insulation and Lightning Protection
☐ 38-112	Lauglin	Carrier-Current Equipment
☐ 38-113	Draper	Transmission-Line Relay Protection
☐ 38-114	Skellett	Narrow-Band Transmission System for Animated Line Images
☐ 38-115	Norwine	Controlling Amplitude Characteristics of Telephone Signals
☐ 38-116	Gaylord	The Pumping System of the Colorado River Aqueduct
☐ 38-117	Skilling	The Electrical Strength of Air at High Pressure
☐ 38-118	Pierce and Hamilton	Phase-Angle Control of System Interconnections
☐ 38-119	Lyon	The Electrostatic Unbalance of Transmission Lines

* These papers have been published in the TRANSACTIONS section of ELECTRICAL ENGINEERING